NATIONAL ENERGY SECURITY POST 9/11

UNITED STATES ENERGY ASSOCIATION

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USEA
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I. INTRODUCTION

THE OIL EMBARGO OF 1973, the Iranian revolution of 1978-79, and the Iraqi invasion of Kuwait in 1990 made abundantly clear the direct link between energy supplies and U.S. economic vitality. Nor are the men and women in the U.S. armed forces forgotten who lost their lives to save Kuwait and help our Persian Gulf allies. Yet these events, and even those sacrifices, pale next to the loss of American lives, on American soil, when 10 terrorists flew two planes into the World Trade Center towers on September 11, 2001, killing more than 3,000 people, many from other nations, but many more local firemen, police officers and emergency team personnel who rushed to respond to the unfolding disaster. Within the hour, passengers in another plane perished in Pennsylvania, ordinary people willing to risk their lives to save the lives of people they would never meet. And then the Pentagon. And then, within days, as the nation caught its collective first breath, anthrax-laced letters arrived in the outer offices of a U.S. Senator and in a Florida newspaper building and on the desk of an assistant to a major network news anchor—all efforts intended to spread panic.

Those closest to these tragic events responded intuitively in memorable, heroic, even inspired ways. Government leaders stepped forward, armed with resolve, and began taking the necessary diplomatic, intelligence-gathering and military actions. Business and labor contributed, lending technical skills, financial resources, office space, workers, a hand, ideas.

Now, a more deliberative and difficult process has begun. People are rightly asking—and wanting answers to—uncomfortable questions. How can we better prepare against future attacks on critical infrastructures, including U.S. energy systems? Are our energy supplies vulnerable to attack? If so, how? Where? How can energy generating and storage facilities be made safer? What about transportation systems and transmission lines? Are government and industry leaders working together to develop contingency plans to protect the public? What policies would enhance U.S. energy security? U.S. national security?

Members of the United States Energy Association (USEA) take these questions seriously. Many of our members continue to work with federal, state and local officials to protect the U.S. energy infrastructure and the public's health. For example, USEA members advise special task forces—such as the National Infrastructure Protection Center (NIPC) and the National Infrastructure Simulation and Analysis Center (NISAC)—and work with federal agencies on these issues through Information Sharing and Analysis Centers (ISACs). Five ISACs are now in operation. One focuses on electric power, another on oil and natural gas, and a third on communications—all vital aspects of energy industry operations. As ISAC members, companies share information on threats, vulnerabilities, countermeasures and best practices with one another and with public officials. Additionally, several member companies serve on the board of the Partnership for Critical Infrastructure Security (PCIS), a joint public-private initiative born quietly in the 1980s that flourished in the 1990s. Moreover, countless American firms, including energy companies, are now assisting the Office of Homeland Security, the Critical Infrastructure Assurance Office (CIAO) and other agencies charged with developing a state-of-the-art National Plan for Critical Infrastructure Protection.

Several months ago, USEA members decided to conduct their own independent review of industry infrastructure safeguards and best practices, and sought ways to improve U.S. energy security. Members identified barriers to increased domestic energy production, and found ways to improve upon the extensive safety laws, regulations and practices that were put into place long before September 11th. USEAmembers also assessed—collectively and by sector—emerging trends in U.S. energy demand, supply, conservation, research and development, regulation, transportation, distribution, storage, and delivery, that frame, and sometime constrain, policy choices. Our goal throughout has been to identify potential energy security vulnerabilities and to develop effective strategies to reduce them.

Our most important finding is an obvious one: U.S. energy security cannot be achieved by closing our border to energy imports or by limiting energy exports. Attempts to do so would cripple the economy, limit trade, slow the creation of wealth around the globe, and delay the spread of technology (and, oftentimes, open markets) to developing nations. Such isolationism would also deprive our statesmen of an important foreign policy tool. Energy is much more than an essential commodity; it is woven into the very fabric of our social order. Consider these facts:

- ▶ More than 50% of the gasoline, aviation fuel, heating oil, diesel fuel and other petroleum products come from a dozen or more nations abroad. Some are friendly, some are not. The answer to increased energy security is diversifying our sources of supply, and the U.S. continues to do so.
- ▶ Hydroelectric, nuclear and coal plants in Canada light, heat and power a growing number of New England homes and industries, just as natural gas pipelines run from Alberta into the Upper Great Lake states to meet energy needs there. U.S. and Mexican officials are working closer than ever before to provide energy supplies to U.S. industry, business and consumers and to supply technology and energy to Mexico.
- ▶ The fall of the Berlin Wall opened much of Eastern Europe to American business practices and technologies. This is particularly evident in the electric utility sector, where USEA members regularly exchange views on utility operations and train East Europeans in market economics and best practices.
- ▶ U.S. petroleum and natural gas exploration and production technologies are the envy of the world, particularly in deep water, and the spread of these technologies continues to create wealth in less developed nations.
- ▶ An agreement between the U.S. and Russia is turning stockpiled Soviet nuclear weapons, once pointed at America, into nuclear fuel to generate electricity for U.S. homes, businesses and industries.
- ▶ The potential demand for clean energy technologies–from clean coal to nuclear and renewable technologies–is large, especially in the developing world as countries expand their energy use and want to do so in the most efficient and environmentally acceptable way possible.

No less important to national security are the considerable, and on-going, energy savings produced by sensible conservation practices and improvements in energy efficiency. Renewables, too, contribute to U.S. energy security, and their contributions in the future undoubtedly will increase. However, in our view, the most effective way to improve U.S. energy security today is to increase the discovery and production of domestic energy; accelerate the development of innovations and technologies that could increase production from existing reserves and/or ensure their transmission or delivery to end-users; remove financial barriers that may slow investment in these improvements; and continue to get the greatest productivity possible from every unit of energy, regardless of its source.

Creating, or expanding on existing public policies that improve U.S. energy security will not be easy. No agency, industry or task force can possibly identify every vulnerability in the U.S. energy infrastructure, and, if they did, limitless funds are not available to eliminate all risk. But of course that should not be our goal. Instead, we should seek to sustain a way of life—our institutional vitality and our personal health, wealth, mobility and freedoms—by accepting and intelligently managing the unavoidable risks of living in an energy-intensive society. Fortunately, a number of tools are at our disposal to help us do so. We possess an abundance of domestic energy in many forms. We are the world's leader in innovation and technology. We have in place vigorous safety regulations and industry practices that contribute to U.S. energy security. Moreover, the energy industry, like other critical components of our society, continually updates contingency plans and practices emergency preparedness drills with state, local and federal agencies. The key to improving our nation's critical energy infrastructures lies in building on existing resources, balancing a number of sometimes competing policy objectives—economic vitality, environmental protection, national security—while preserving the personal freedom and institutional flexibility needed to meet tomorrow's challenges.

This study is a step in that direction. It reflects the best efforts of USEA members to summarize our core principles and present broad policy recommendations (Section II). It also includes an overview of global energy trends, as presented in the U.S. Department of Energy/Energy Information Administration's (DOE/EIA) *Annual Energy Outlook 2002*, that will shape the choices available to policymakers and industry leaders (Section III); examines industry-specific trends; and concludes each discussion with energy security policy options specific to that industry (Section IV). The critical roles of energy efficiency, conservation and energy R&D technology are examined (Sections V and VI). The study ends with some brief concluding thoughts about energy security in the past, present and future (Section VII).

The challenges of the 21st century will be unlike any other. Technological innovation, global information systems, expansive capital markets, and the ability to move vast energy supplies rapidly across national borders has enriched lives, countries, continents—and given terrorists the tools to attack our citizens, our economy and our way of life on our soil. The quicker we get our house in order, the sooner we will prevail.

II. CORE PRINCIPLES AND POLICY: KEYS TO ENHANCED U.S. ENERGY SECURITY

Energy security is a multi-faceted issue. In its most fundamental sense, energy security is assured when the nation can deliver energy economically, reliably, environmentally soundly and safely, and in quantities sufficient to support our growing economy and defense needs. To do so requires policies that support expansion of all elements of the energy supply and delivery infrastructure, with sufficient storage and generating reserves, diversity and redundancy, to meet the demands of economic growth. USEA, in its 2001 report, *Toward a National Energy Strategy,* made a number of recommendations that remain important to enhance energy security today.

The Post 9/11 environment demands that these policy recommendations be revisited with a new resolve and perspective. An adequate supply of energy to end users must also consider the threats associated with geo-political disruptions and the potential of physical attack by acts of war or terrorism on energy infrastructure or through use of the energy infrastructure to deliver physical, biological or chemical weapons.

The recommendations in this report build on the sound fundamentals for energy security based on diversity of supply of natural resources, generating capability, refining capacity, reserves and delivery systems. In addition, recommendations are made for technology enhancements and policy considerations that will permit a complementary relationship between the interests of the private and public sectors for physical security.

In consideration of the following Core Principles and Policy Recommendations, it is vitally important that actions be taken consistent with the long-term nature of energy infrastructure. Energy infrastructure takes a long time to put in place. Once built, the life of the durable assets is also very long. The United States pursues policies supportive of long-term economic growth and security. Energy needs reflect economic and climate cycles. Periods of reduced need owing to these cyclic effects are not good reason to assume victory. Energy use will grow inexorably with the economy and the population. Energy policy must reflect this long-term reality and be made with the same durability expected of the long-term economy. The United States will need increased contributions toward energy security from all available sources over the long term including conservation, renewables, all traditional sources of energy and some that are only a glimmer in the eyes of today's research community.

CORE PRINCIPLES

- **Diversity of Fuel Source**s—Diversity of fuel supplies increases national security. So does increased domestic production. Moreover, given the inherent uncertainty of energy markets and of efforts to project future trends, diversity of fuel supplies has proven more efficient than picking "winners and losers" when addressing long-term problems.
- **Economic Efficiency**—Economic efficiency is maximized when competitive markets guide decisions affecting global energy supply and demand.
- **Accelerated Innovation and R&D**—Research and development often spur improvements in energy technologies and can produce long-term cost savings while reducing environmental impact and increasing national security. Government has an essential

and appropriate role in research undertaken to address environmental and national security concerns, and partnerships between public and private sectors (domestic and international) can speed this process.

- **Contingency Planning and Emergency Preparedness**—Partnerships between the public and private sector, at all levels, is key to developing and implementing effective contingency plans. Existing laws, regulations and industry practices form a solid basis for any additional improvements.
- **Balance Energy Security, Economic and Environmental Objectives**—Government officials can use regulation and incentives to enhance public health, safety and consumers' rights. Decisions to use these policy tools should be based on sound science and realistic economic, national security and environmental needs. Such decisions also should be timely, consistent and coordinated so energy security, economic and environmental objectives are kept in balance.

POLICY RECOMMENDATIONS

A. Encourage Conservation and Energy Efficiency

- Better educate Americans about energy use, production and their choices. Most Americans do not understand where their energy comes from, where it is used and how their choices help drive energy security, conservation and new technologies.
- Increase R&D spending on energy efficiency and renewable energy. Government investments in primary technology development can contribute significantly to advances in both energy efficiency, which in and of itself is conservation, and renewable energy technologies.
- Wherever possible, let price signals regulate markets, demand and consumer decisions. Prices should not be artificially established, maintained or subsidized.

B. Maintain Diversity of Energy Supplies while Enhancing Domestic Production and Delivery

- Develop consistent land administration policies and procedures among the numerous federal and state agencies that oversee energy production and development.
- Work closely with our North American Free Trade Agreement (NAFTA) neighbors to create a "shock absorbing" energy system, one that ensures efficient development, trade and use of energy production, development, transmission and end use.
- Use loan guarantees, investment tax credits and accelerated depreciation to attract capital to energy projects that often require large sums of money and provide only low to modest returns on investment.
- Encourage energy infrastructure investments in all sectors—production, transport, transmission and end use—by streamlining regulations that are redundant or conflicting.
- Diversify electrical generating facilities and ensure adequate returns that will attract the necessary investment in transmission and delivery systems in order to overcome transmission congestion, regional isolation and to increase the redundancy in the electric system.

- Reform tax codes that limit infrastructure investment.
- Allow refiners and other energy producers to recapture the full cost of meeting new environmental regulations.
- Encourage the restructuring of wholesale electricity markets and trading arrangements as sought by the Federal Energy Regulatory Commission by removing tax impediments to the spin-off of transmission assets and tax provisions that prevent the full participation of state and locally owned utilities and rural electric cooperatives in emerging competitive markets.
- Allow electric utilities to depreciate property used in the transmission or generation of electricity on an accelerated basis.
- Repeal the Contribution In Aid of Construction (CIAC) tax.
- Encourage deployment of renewable energy supplies when doing so will strengthen the energy infrastructure and/or increase U.S. energy security.

C. Strengthen Contingency Planning and Emergency Preparedness

- Because nuclear power plants, pipelines, port facilities, transmission hubs, hydroelectric structures and many other vital U.S. energy components could be terrorist targets, one government agency should be tasked with the oversight and coordination responsibility for all energy infrastructure systems. Doing so will ensure that intelligence and information sharing, alert notification, and responsiveness by the energy industry will be timely and effective.
- The government agency in charge should also decide whether government or the private sector is primarily responsible for the defense of specific facilities and energy systems.
- Conduct a comprehensive review to determine what actions are required to provide reasonable protection of the U.S. energy infrastructure, both long and short-term.
- Fill the Strategic Petroleum Reserve (SPR) to its maximum capacity and continue to use the SPR as an emergency mechanism only, and increase U.S. uranium enrichment capabilities.
- Work closely with friends and allies to enhance international cooperation in preparing for oil supply disruptions. Encourage strategic oil inventory holdings in International Energy Agency (IEA) and non-IEA member economies.
- Develop a military liquid fuels reserve that is not dependent on imported fuel, i.e., a reserve based on coal to liquid technology.
- Reestablish a new mechanism that encourages contingency planning. This mechanism has been lost under the current trend toward deregulation. The new mechanism should look long-term and have the ability to resolve eminent domain and inter-state or inter-regional disputes.

D. Balance Energy Security, Economic and Environmental Concerns

- Where appropriate, lessen the burden of environmental and land use regulations, licensing and permitting requirements so that energy security needs can be met more effectively.
- Pursue solutions, such as voluntary climate change initiatives, that are consistent with energy security, environmental and economic concerns.

- Avoid use of unilateral economic sanctions, which can interfere with U.S. energy security and energy efficiency.

E. Accelerate R & D to Create and Deploy Advanced Energy Technologies

- Establish public/private research and development programs whose goal is to create and deploy advanced technologies that reduce energy infrastructure vulnerability.
- Focus R&D initiatives on all aspects of prevention, mitigation and recovery from attacks upon our energy system.
- Recognize that these technologies will also enhance the reliability and capacity of the U.S. energy infrastructure, regardless of the presence or absence of terrorist attacks.
- Expand research on alternative fuels that are capable of reducing energy import dependence or improving environmental quality.

III. GLOBAL AND U.S. ENERGY OUTLOOK

U.S. energy security is closely linked to global energy markets and trends, as well as to North American energy resources, energy production, transportation and storage systems, and to changing patterns of consumption. The U.S. Energy Information Administration[1] projects the following trends during the next two decades:

By 2020, World Oil Demand is projected to increase by nearly 44 million b/d and of this increased demand:

- ▶ Almost 60 percent of the incremental demand will be in developing countries;
- ▶ 60 percent of the new demand will be in the transportation sector;
- ▶ 63 percent of the new demand will be supplied by OPEC members;
- ▶ 44 percent of the new demand is set to come from the Persian Gulf region.

All of these trends have enormous implications for global and U.S. energy security policymakers.

By 2020, U.S. Energy Patterns are Projected to Shift Dramatically:

- ▶ Total U.S. primary energy consumption is projected to grow from 99 quadrillion Btu in 2000 to 131 quadrillion Btu in 2020—an increase of about one-third.
- ▶ The transportation sector (96 percent supplied by oil) is expected to grow more rapidly than any other, increasing from about 13 mmb/d in 2000 to about 19 mmb/d in 2020.
- ▶ Natural gas consumption is projected to grow from 23 trillion cubic feet in 2000 to 34 trillion cubic feet in 2020, primarily as a result of rapid growth in demand for electricity generation; domestic natural gas production is projected to increase from 19.1 Tcf to 28.5 Tcf. Net imports of natural gas, primarily from Canada, are projected to increase from 3.5 Tcf in 2000 to 5.5 Tcf in 2020.
- ▶ Coal consumption is projected to increase from 1,081 million tons in 2000 to 1,365 million tons in 2020. Coal for electricity generation constitutes about 90 percent of the total coal demand; coal production will grow in line with demand requirements.
- ▶ Petroleum is expected to remain the dominant fuel in U.S. markets maintaining about 40 percent market share; domestic crude oil production remains relatively stable in the projection.
- ▶ Renewable energy production is projected to increase from 6.5 quadrillion Btu in 2000 to 8.9 quadrillion Btu in 2020; renewable energy's market share is projected to remain stable.
- ▶ Total U.S. electricity demand is expected to increase at an average annual rate of 1.8 percent through 2020, while natural gas generation is projected to increase at an average annual rate of 5.2 percent and coal is projected to increase at a 1.1 percent annual rate.

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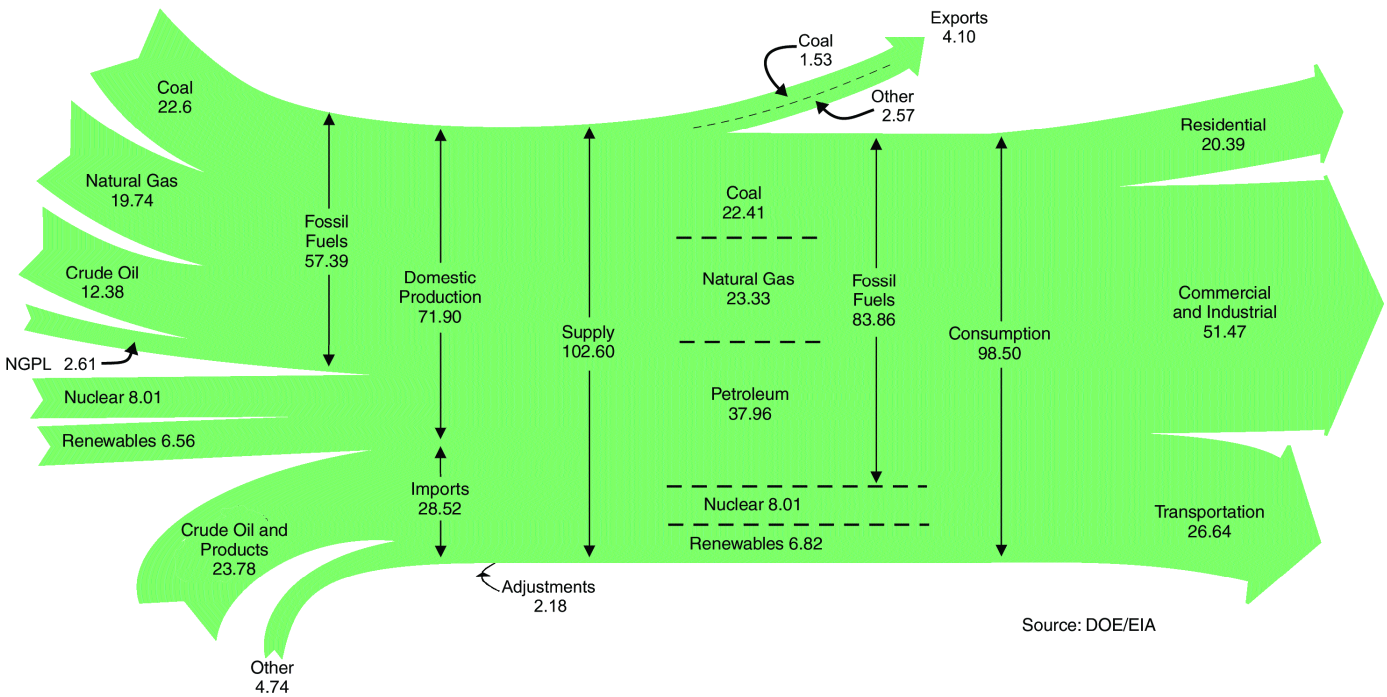
[1] The DOE/EIAprojections are not statements of what will happen but of what might happen, given the assumptions and methodologies used. The projections are business-as-usual trend forecasts, given known technology, technological and demographic trends, and current laws and regulations. Thus, they provide a policy-neutral reference case that can be used to analyze policy initiatives. Source: DOE/EIAAnnual Energy Outlook 2002 and International Energy Outlook 2002.

- EIA projects that approximately 374 gigawatts of new generating capacity, including cogeneration, will be installed by 2020, an increase of 41 percent (net of retirements) in the nation's generating capability.
- Energy intensity (thousands of Btu per dollar of GDP) is projected to fall 1.5 percent per year from 10.77 in 2000 to 7.92 in 2020.

IV. ENERGY SECTOR ANALYSES

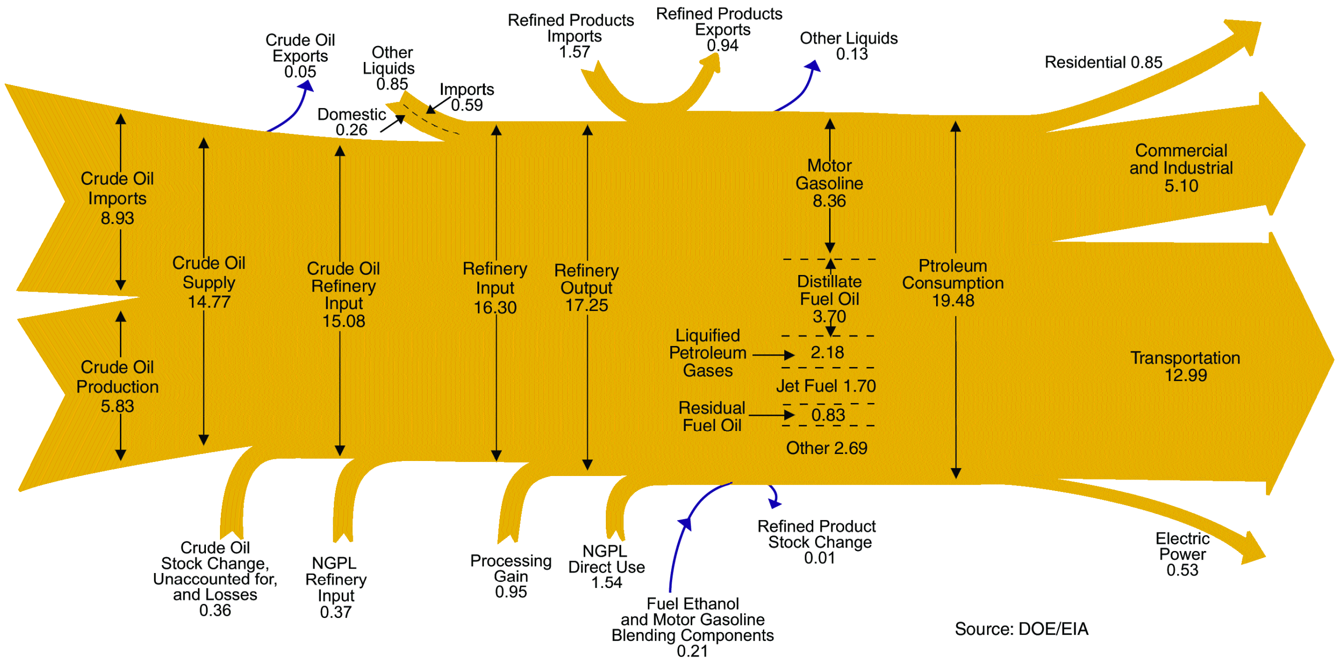
ENERGY FLOW, 2000
(Quadrillion Btu)



PETROLEUM

PETROLEUM FLOW, 2000

(Million Barrels per Day)



OVERVIEW

Following the events of September 11th, USEA members carefully scrutinized the physical security of their facilities. Many facilities already had a number of security measures in place, given the regulations in place to protect public health and the importance of energy to the national economy. Just as the government checked the security of its Strategic Petroleum Reserve, the petroleum industry reevaluated all aspects of security and implemented appropriate actions, both to reduce the risk of supply disruptions and to maintain proper protection of public health.

For example, companies examined the entire chain of supply—production, transportation, refining, marketing and distribution. Industry leaders also took note of the importance of energy prices to U.S. national security. Widely varying prices can erode a nation's economic stability by undermining the reliable delivery of supplies. This overall balance of supply—of supply and price—is best ensured by redundancy, robustness and diversity of supply sources.

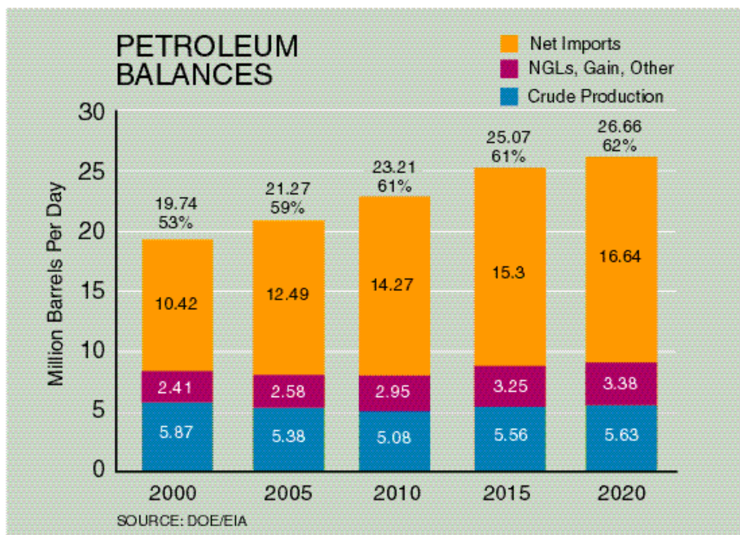
Energy supplies are redundant when additional resources can be brought to consumers when one source is threatened or interrupted. Energy supplies are robust when sufficient resources are available to insure the constant flow of supply to end-users. And energy supplies are diverse when a sufficient number of suppliers and supply chains can insure that the flow of energy supplies will continue, even when a supplier or chain is temporarily interrupted.

SECURITY OF SUPPLY

The petroleum industry supply chain is diverse but lengthy. The supply chain starts at the wellhead, continues through gathering lines and is transported to refineries either by ship or pipeline. Following the refining process, petroleum products are then transported by pipelines, ships, barges or trucks to large storage terminal facilities. Ultimately, products, such as gasoline and jet fuel, are delivered by truck to local gasoline stations and airports. Because a huge volume is moved each day—over 800 million gallons—petroleum supply chains are redundant, robust and diverse. For example, hundreds of thousands of wells exist in the U.S. and worldwide. Similarly, thousands of pipelines and ships, hundreds of thousands of miles of pipelines, and hundreds of thousands of trucks work together to deliver petroleum products to residential, commercial and industrial consumers.

Because the petroleum supply network is so broad, security concerns naturally surface. In fact, looking to the future, such concerns may increase if not properly addressed. Currently, the U.S. imports over 50 percent of its petroleum supplies from abroad, a number that some predict may grow to more than 60 percent during the next ten years and even more thereafter.

This growth in net U.S. imports is the product of two trends—growing overall demand for oil and declining, or at best, stagnant, domestic supply.



However, policies aimed solely at reducing petroleum imports would not, per se, enhance energy security. Because oil is traded in a global market, disruptions in global markets will be felt worldwide, and will affect the price of domestic and foreign petroleum equally. As consumers in that market, our vulnerability to such disruptions is not reduced solely by reducing our imports. In fact, if the reduction in imports is accomplished by forced reductions in consumption or development of non-competitive substitutes, the economic costs incurred may make us substantially worse off. A more effective approach is to diversify the sources of petroleum supply, a strategy effectively employed by the U.S. and other industrial nations following the oil embargoes and price hikes of the 1970s and early 1980s. The pie chart on the following page depicts current import shares.

This import pattern has changed significantly over the past 15 years as the U.S. has diversified its source of imports and thus reduced its dependence on OPEC and Persian Gulf petroleum suppliers.

Canada, Mexico, Nigeria, Norway and Angola, in particular, have dramatically increased the exports of crude oil and petroleum products to the U.S. during this period. In fact, OPEC and Persian Gulf market shares of U.S. imports peaked in 1977 at 70.3 percent and 27.8 percent respectively. The current OPEC share stands at approximately 47 percent and the Persian Gulf share stands at about 23 percent. Moreover, since OPEC petroleum import share peaked in 1977, the U.S. has brought online additional oil production from Alaska and

MAJOR SUPPLIERS OF U.S. IMPORTED CRUDE OIL AND PETROLEUM PRODUCTS (MMbpd)

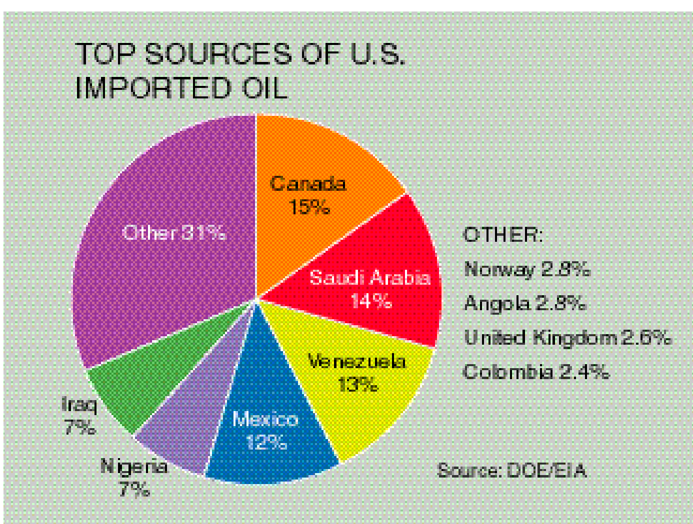
Country	Imports in 1985		Imports in 1995		Imports in 2000	
	Total	Crude	Total	Crude	Total	Crude
Canada	0.770	0.468	1.332	1.040	1.807	1.348
Saudi Arabia	0.168	0.132	1.344	1.260	1.572	1.523
Venezuela	0.605	0.306	1.480	1.151	1.546	1.223
Mexico	0.816	0.715	1.068	1.027	1.373	1.313
Nigeria	0.293	0.280	0.627	0.621	0.896	0.875
Iraq	0.046	0.046	0.000	0.000	0.620	0.620
United Kingdom	0.310	0.278	0.383	0.341	0.366	0.291
Norway	0.032	0.031	0.273	0.258	0.343	0.302
Colombia	0.023	0.000	0.219	0.207	0.342	0.318
Angola	0.110	0.104	0.367	0.360	0.301	0.295
Virgin Islands	0.247	0.000	0.278	0.000	0.291	0.000
Kuwait	0.021	0.004	0.218	0.213	0.272	0.263

Source: DOE/EIA

from deepwater regions of the Gulf of Mexico. This additional domestic production and our diversification of import supply have so lessened OPEC market power such that the real price of oil has declined from over $70 (current dollars) per barrel in 1980 to around $25 per barrel in May 2002.

SECURITY OF DISTRIBUTION AND STORAGE FACILITIES

Domestic crude oil pipeline capacity and domestic shipping capacity pose fewer security concerns than do petroleum imports. For example, the U.S. built crude oil pipelines to move large domestic supplies closer to U.S. refineries, thus avoiding the need to import even larger quantities of oil. U.S. crude oil production has declined some 40 percent since peaking in 1970, and pipeline capacity for crude oil remains considerable. Currently, foreign shipping capacity appears to be both adequate and diverse. This diversity of the petroleum transport fleet makes security of supply less of a concern than it otherwise would be. However, regulations such as the requirement that all petroleum tankers entering U.S. waters be double hulled may reduce available capacity for shipping petroleum to the United States.

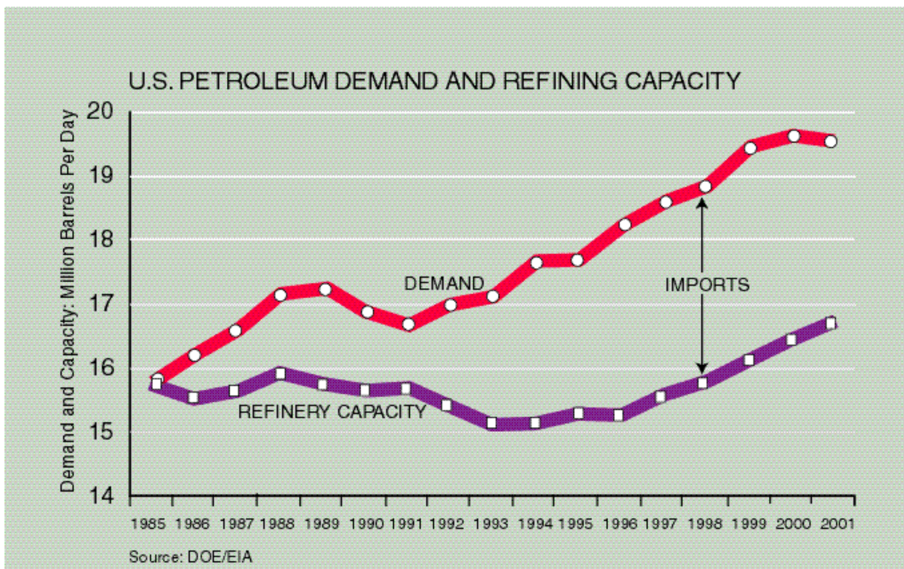


Available refining capacity is an even greater source of concern for U.S. energy security. During the past 20 years, the number of U.S. refineries has dropped by more than 50 percent, to approximately 150 facilities. In fact, no new major refinery has been built in 25 years on the

U.S. mainland, and the nation's overall distillation capacity has declined more than 10 percent since 1981. Not surprisingly, the demand for refined petroleum products has exceeded U.S. refinery capacity since the mid 1980s and, as the graph below depicts, the disparity between U.S. product refining capacity and U.S. product demand has continued to expand.

Companies continually upgrade and expand the remaining 150 U.S. refineries in order to increase petroleum supply, but increases have been limited by regulations on refinery emissions and fuel quality. Today, U.S. petroleum companies must produce 18 types of gasoline to meet federal, state and local air quality regulations. As a result, existing facilities turn little profit and for two decades have been unattractive to new investors.

This combination of regulated fuel production and limits on production capacity has also contributed to price volatility during the past two years. For example, in the Spring of 2000, just as demand began to increase, Phase II reformulated gasoline was introduced, imposing strict fuel specifications on refineries that already faced limited crude oil supplies. This regulatory burden, combined with pipeline problems, refinery outages and weather problems led to sharp price spikes. True, fuel remained available, but consumers, faced with price spikes, could hardly be characterized as secure.

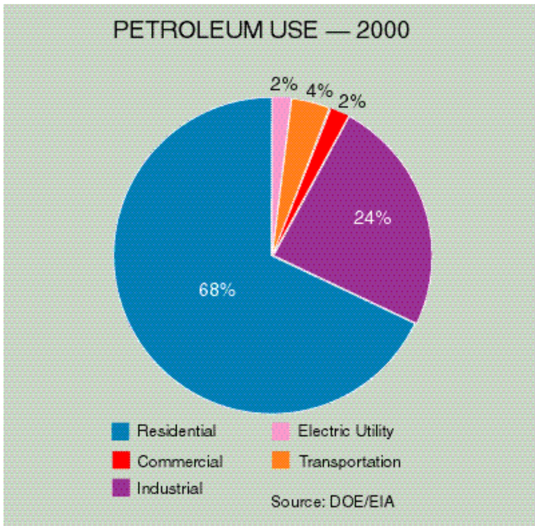


Pipelines are another critical component of the petroleum supply chain. The current pipeline network is vast. Hundreds of thousands of miles of pipelines carry 70 percent of U.S. product deliveries, including heating fuel, gasoline, diesel fuel and aviation fuel. Some are large transmission lines, others medium sized feeder lines and smaller distribution lines. The disruption of a single major pipeline for even a short period of time—as happened in 2000—can put significant upward pressure on consumer prices.

The Department of Energy projects even greater capacity constraints on pipelines and refineries in the future. As the graph above on import shares indicates, during the next 20 years petroleum demand is expected to grow around 7 million barrels per day, to a total of more than 26 million barrels per day. The DOE projects that 3 million barrels per day will be refined domestically, and the balance—4 million barrels per day—will be imported. This means two things: first, petroleum product pipelines and terminal facilities will need to be expanded to handle the 3 million barrels per day increase; second, additional port facilities, pipelines and terminals for refined imports likely will be needed to handle the 4 million-barrel per day increase in refined product imports.

Terminal facilities are already under great pressure to meet ever increasing environmental regulations, land use objections and local pressure to develop previously vacant land around many of these facilities. In fact, overall storage capacity has declined in recent years as local leaders won development fights to locate hotels and resorts on areas once occupied by large tank farms. Today, U.S. petroleum facilities store less product than before, and this reduction in storage capacity has potential security implications, especially as overall domestic supplies continue to decline relative to demand.

Trucks, service stations, convenience stores, chain grocery stores and other large volume retailers are the final link in the petroleum supply chain. Most of these facilities are owned by small businessmen and women who compete in the classic Adam Smith style. These often locally owned operations give the industry's supply chain diversity, robustness and redundancy. Among this group, the large volume—low cost retail outlets, known as Hypermarts, supply not only low-cost gasoline and diesel fuel, but other goods and services to attract consumers.



Viewed as a whole, the current petroleum supply chain exhibits both strengths and vulnerabilities. For example, the petroleum industry—and particularly the refinery process—is dependent on other forms of energy, including electricity, coal and natural gas. In short, U.S. energy security is built domestically on a mutual interdependence among the various energy sectors. This system can be strengthened by taking the actions recommended at the conclusion of this section. However, the single most important step that policymakers can take to improve U.S. energy and national security would be to pass legislation that enhances domestic petroleum supply and diversifies foreign imports.

EMERGENCY PREPAREDNESS AND PUBLIC SAFETY

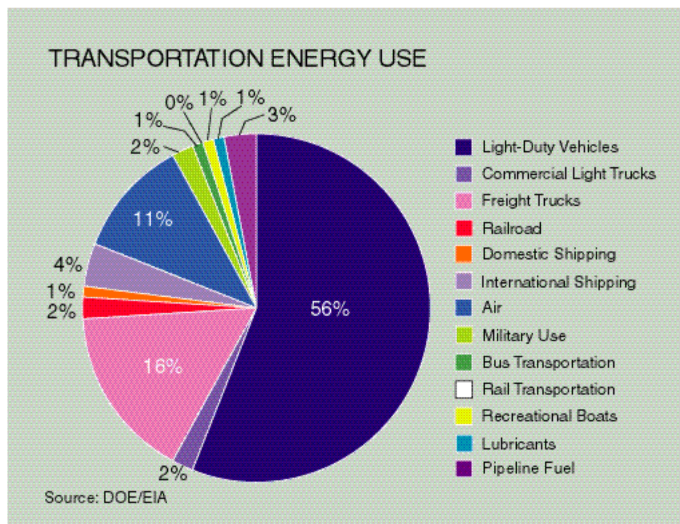
Prior to September 11, 2001, the industry had in place many practices that insured public safety and had detailed plans for emergencies. The emergency preparedness was developed for cases of crime, vandalism, weather and other physical disasters and equipment failure. These measures included guards and fences, surveillance, background checks, extensive interaction with residents and police authorities, plans and drills on emergency response and restoration of facilities.

After September 11, these activities were intensified and frequent interactions with U.S. Homeland Security agencies were added. Communication networks between the operators of facilities and government agencies were developed to share information on suspicious activities, threats and best practices in security actions. These activities will continue as long as necessary.

WHAT LIES AHEAD?

The federal government needs to give energy supply its highest national security priority. America's growing dependence on imported crude oil and petroleum products is an excellent place to start. However, policies undertaken to enhance supply and reduce petroleum imports should be evaluated in the context of where these supplies originate and where they are used. Only then will policymakers have conducted a realistic assessment of the true opportunities for import reduction. Here are several other trends and issues that deserve the close attention of policymakers:

- The United States currently produces almost 6 million barrels per day of crude oil. This is down some 40 percent since domestic production peaked in 1970. On the other hand, significant additional amounts of crude oil could be produced domestically, given a proper balance between national security concerns and environmental regulations.
- Opponents to increased domestic production often cite the fact that only 2% of the world's petroleum reserves are found in the United States. While this figure is factually correct, it misses the point—at issue are new discoveries of petroleum from undiscovered resources, not production from existing fields. More specifically, a recent U.S. Geological Survey estimates that around 125 billion barrels of undiscovered crude oil and nearly 18 billion barrels of undiscovered natural gas liquids exist in the United States.
- These numbers are comparable to known reserves in Iraq or Kuwait and about one-half of the known reserves in Saudi Arabia. Technical, environmental and infrastructure factors may limit access or development of a significant amount of these undiscovered U.S. petroleum reserves, but exploration and production of the remainder—which still would be sizable—could significantly reduce U.S. dependence on petroleum imports. Unfortunately, significant restrictions on permitting and drilling exist in important areas such as the Rocky Mountains. While leases have been issued for promising resources, restrictions in the issuance of permits to drill for oil and gas are significant. Seasonal, surface occupancy and resource plan restrictions are particularly important. While it is essential to get a lease for a resource, if a permit to drill is not issued, no oil or gas can be produced.



- During the past 30 years, Americans have learned to use less petroleum to produce more goods and services. The United States uses 52 percent less petroleum today to produce the same constant dollar GDP than it took in 1973. The constant introduction of more cost-effective technologies, more fuel-efficient industrial processes and more fuel-efficient vehicles has made these gains possible.
- Identifying future energy efficiency gains begins with an understanding of where and how Americans use petroleum. The chart on the previous page presents our current sectoral uses of petroleum.

Residences, commercial facilities and electric utilities account for only about 8% of total U.S. petroleum consumption. Industrial use is greater—at 24 percent—and transportation use tops the chart at 68 percent. Clearly, efficiency improvements must focus on transportation and industrial use if they are to have a significant impact.

- Given our vigorous participation in a global economy, many economists and policy experts believe that American industry already has every incentive to use petroleum as efficiently as possible. This places the focus on transportation, a sector that is further subdivided into personal vehicles, trucks, railroads, airlines, marine vessels and the like. The chart on the previous page depicts usage of energy by all transportation modes.

- All of these modes except light-duty vehicles are used for commercial or recreational purposes, so the search for energy efficiency gains can be further refined to light-duty vehicles—passenger cars, pickup trucks and sport utility vehicles. Taken together, these vehicles consume 120 billion gallons of petroleum per year out of total petroleum consumption of 302 billion gallons, or 40 percent of our total petroleum consumption. However, while the target for energy efficiency gains may be clear, hitting that target has proven exceedingly difficult, for a number of years and for a variety of reasons.
- Typically, advocates of higher Corporate Average Fuel Economy (CAFÉ) standards focus solely on improving new vehicle efficiency. Many advocates fail to grasp consumer behavior under different scenarios. For example, the most significant hurdle to lower fuel consumption is the size of the existing fleet. Approximately 200 million light duty vehicles are now on the road, and these vehicles may be in service for 15, 20 or more years. The introduction of more energy-efficient vehicles will not force these older vehicles off the road. The first impact of CAFÉ is to raise the cost of new vehicles relative to older ones. This change reduces turnover by reducing sales of newer more efficient vehicles thereby reducing overall efficiency. In addition, the older vehicles will be sold to other consumers who continue to use them for many years. As a consequence, it takes a decade or more to turn over the entire fleet and thus achieve the fuel-efficiency gains that new vehicles promise. In short, the arguments that higher CAFÉ would quickly reduce U.S. fuel consumption are simply not true.
- Higher CAFÉ may prove to be self-defeating. History shows that consumers drive their vehicle more miles when the operating costs go down, so the total amount of petroleum saved from higher CAFÉ standards is likely to be less than its advocates project. For example, between 1980 and 2000, vehicle efficiency improved by 38.3 percent (cars only) while miles per vehicle increased by 31.1 percent (cars only). As a result, gallons per vehicle declined from 576 in 1980 to 546 in 2000—hardly a significant decline in fuel consumption. Initiatives to improve energy efficiency in other products face the same problem. As manufacturers have improved the efficiency of the light bulb, people have tended to leave their lights on longer. Also, the improved efficiency of vehicles has contributed to allowing consumers to live further from work sites and allowed the expansion of suburban sprawl. This further increased the use of gasoline. In short, a considerable gulf exists between what is technically possible from an engineering perspective to save energy, and what consumers choose to do—or not do—to reduce overall energy use.

POLICY RECOMMENDATIONS

- **Better Educate Americans about Energy Use and Production**

  Americans do not understand where their energy comes from, where it is used and how the supply chain of energy can be improved. Further, Americans have not had sufficient information on the possibility of reducing energy use. Information on the fuel use required for a variety of activities would allow residential, business and industrial consumers to make proper energy use choices.

- **Increase R&D Spending on Energy Efficiency and Renewable Energy**

  New technologies can be developed to improve energy efficiency and to make renewable energy resources more cost-competitive. Government investments in primary technology development can contribute significantly to advances in both energy efficiency and renewable energy technologies.

- **Fill the Strategic Petroleum Reserve**

  The original intent of the Strategic Petroleum Reserve legislation was to stockpile one billion barrels of crude oil. However, Congress has appropriated only enough funds to fill it with 570 million barrels of oil currently. Monies should be appropriated to fill the SPR to capacity.

- **Develop Additional Domestic Oil and Natural Gas Supplies**

  Significant amounts of undiscovered oil and gas resources can be developed in an economically and environmentally responsible manner. Large undiscovered resources are estimated by the USGS to exist in parts of Alaska – NPR-A and ANWR, and the Gulf of Mexico. The removal of cumbersome, conflicting and counterproductive restrictions on access to these potential resources would significantly enhance U.S. energy security.

- **Streamline Regulations to Encourage Energy Infrastructure Development**

  Conflicting and overlapping regulations hinder the development of new refinery, pipeline, port and terminal infrastructure. Regulations can be streamlined to insure that this infrastructure will be developed in a timely manner.

- **Reform the Tax Code**

  The current U.S. tax code does not enable refiners to recover the full cost of the environmental regulations that they have had to meet in recent years. As a result, the rate of return in the refining industry has been very low. Addressing these tax constraints would enable refiners to properly invest in needed infrastructure improvements.

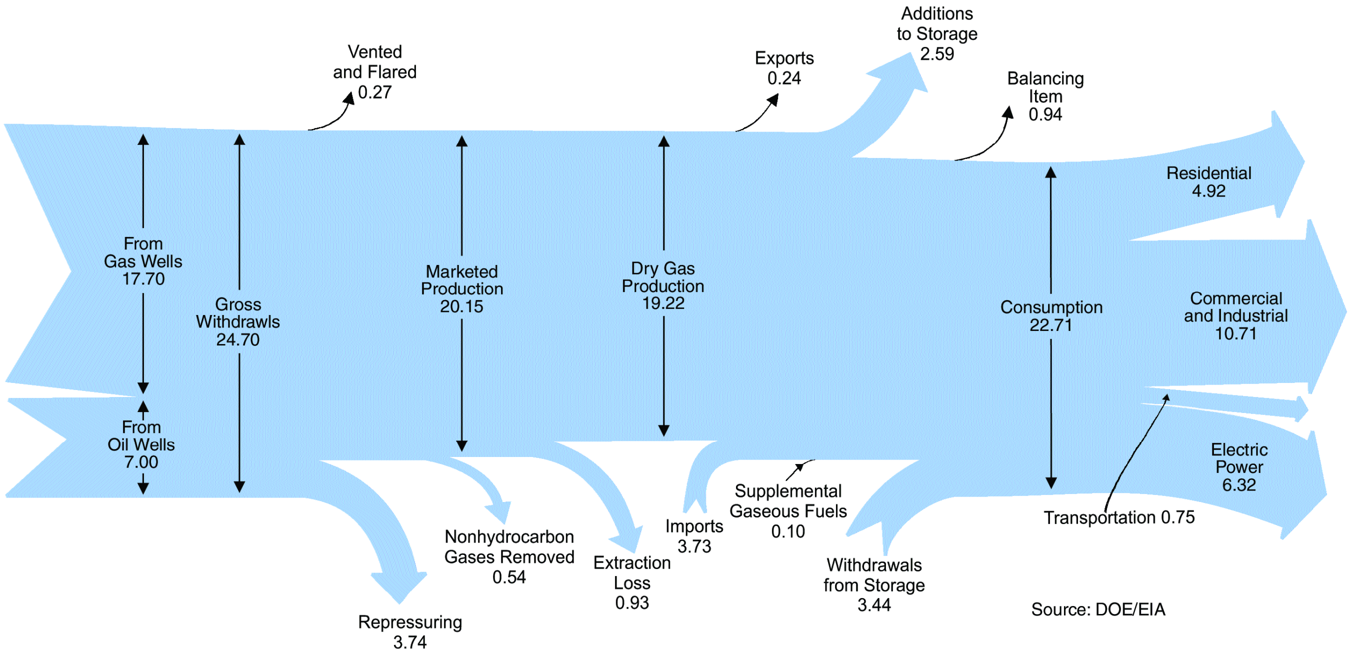
- **Substantially Limit Unilateral Economic Sanctions**

  Unilateral economic sanctions are not effective. This practice should be reviewed and, in most cases, set aside, for it can interfere with U.S. energy security and energy efficiency.

NATURAL GAS

NATURAL GAS FLOW, 2000

(Trillion Cubic Feet)



OVERVIEW

Natural gas—a fossil fuel composed almost entirely of methane—accounts for approximately one-quarter of the nation's primary energy consumption. Residential and commercial uses of natural gas include space heating, water heating, cooking, and clothes drying. Industrial customers rely on natural gas both as feedstock in chemicals and in process applications. Agriculture is a major user of natural gas based fertilizers and for crop drying. Moreover, power plants use natural gas to generate electricity, while private citizens use it for space heating and cooling, as a vehicle fuel and in fireplaces.

Natural gas is an inherently clean and efficient fossil fuel. It is a naturally occurring hydrocarbon mixture, which is principally found in underground formations of porous rock. Its simple chemical composition is a molecule of one carbon atom and four hydrogen atoms (CH_4). When methane is burned completely, the principal products of combustion are carbon dioxide and water vapor.

Natural gas has fewer emissions than coal or oil. Oil and coal compounds have much more complicated molecular structures than natural gas, including a higher ratio of carbon and various sulfur and nitrogen compounds. Natural gas combustion results in virtually no atmospheric emissions of sulfur dioxide or small particulate matter, and far lower emissions of carbon monoxide, reactive hydrocarbons, nitrogen oxides and carbon dioxide than combustion of other fossil fuels.

Three segments of the natural gas industry deliver natural gas from the wellhead to the consumer. Production companies explore, drill and extract natural gas from the ground.

Transmission companies operate the pipelines that link gas fields to major consumer areas. And local utilities, acting as distribution companies, deliver natural gas to individual customers. The number of natural gas consumers has grown through the years, and now totals nearly 175 million Americans. Natural gas flows from more than 300,000 producing wells and is transported by about 180 natural gas pipeline companies to more than 1,200 gas distribution companies who provide customer service in all 50 states.

SECURITY OF SUPPLY

Natural gas is among the most secure fuels available to the United States. Natural gas is:

- **Domestic** – Supply is not dependent on overseas sources, with over 99 percent of the supply coming from North America, 84 percent from U.S. production and 15 percent from Canada in 2000.
- **Abundant** – Based on estimates of the U.S. resource base, there are enough gas resources for at least 60 years at current production levels. This excludes the import potential from Canada and the largely untapped resource base of Mexico.
- **Efficient** – Natural gas applications utilize less total energy compared to most of the competing energy options, helping to conserve our energy resources.

The natural gas resource base is not only geographically secure, the sources of natural gas are increasingly diverse. For example, coal bed methane—which accounts for 7 percent of domestic gas production—was not recognized as an important source 10 or 15 years ago. Moreover, technological advances, including three-dimensional seismology, horizontal drilling, and innumerable computer-related breakthroughs have made natural gas exploration and production more efficient and, in many instances, safer.

SECURITY OF UTILITIES, PIPELINES AND STORAGE FACILITIES

For more than a century the natural gas industry has faced—and met—countless natural threats to its utilities, pipelines and storage facilities, including floods, hurricanes, tornadoes and earthquakes. As the industry grew and as its pipelines have extended into more and more regions of the country, industry leaders have developed safeguards to ensure that natural gas is safely delivered to customers.

The threat of terrorism is a recent phenomenon, and these same companies are now focused on emergency response and security measures. Matching wits with past natural disasters has helped companies develop a number of effective security measures that can be applied to the threat of terrorism. Recent industry investments totaling billions of dollars undertaken to avoid potential Y2K problems also helped prepare utility companies for cyber security threats. This said, leaders in the gas utility sector are nevertheless re-examining all safety and security procedures in light of the terrorist attacks of September 11th. The industry will continue to enhance its security programs and practices as new security opportunities and technologies are identified.

Natural gas companies already have in place extensive contingency plans for responding to threats against their physical and information infrastructures. When the nation came under attack on September 11th, natural gas utilities began to operate at a state of “heightened alert." Under established security procedures, this means that gas companies identified "critical" areas of their systems and ensured that these areas were secured by the most appropriate means. Sometimes this meant deploying additional security personnel to a particular site; other times, sites and pipelines were monitored more frequently by remote devices. The Office of Homeland Security has now developed a color-coded system to alert the public to the different levels of terrorist threat. Industry leaders will use this set of guidelines, as well as other appropriate information, to protect natural gas operations as much as possible.

EMERGENCY PREPAREDNESS AND PUBLIC SAFETY

For decades, all natural gas utilities have had to comply with Department of Transportation (DOT) regulations that spell out in detail what emergency procedures must be followed to minimize hazards in the event of a gas pipeline incident. These plans address such issues as establishing and maintaining adequate means of communication with government emergency response officials, providing appropriate emergency procedure training for company response personnel, and understanding that different types of events require different emergency responses.

Having participated in a number of emergency preparedness drills, natural gas utilities have well-established coordination and communication procedures with local firemen, police and other emergency officials. Many of these procedures exceed federal requirements, especially in the nation's large metropolitan areas. Furthermore, many gas utilities maintain relationships with other gas companies in their region so that they can provide assistance to any utility under duress, much as regional electric utility companies have learned to help their neighbor utility to recover from severe ice or wind damage to power lines.

Moreover, because the natural gas delivery system contains substantial redundancy, in an emergency natural gas operators could use a system of valves and compressors to redirect or shut down the flow of gas. The amount of gas pressure also can be controlled, thus limiting the possible spread of a local hazard to other components in a natural gas delivery system.

WHAT LIES AHEAD?

Natural gas utilities remain committed to delivering safe, clean natural gas to a growing number of residential, commercial and industrial users. However, the challenge today not only to meet increased supply demands and ever tighter environmental standards; rather, the industry now is also called upon to work with policymakers and local officials to protect its existing infrastructure and to anticipate potential national security risks associated with this form of energy. Natural gas utilities are eager to work with local, state and federal government officials to ensure that natural gas enhances U.S. energy and national security. The place to start, is with the facts firmly before all parties:

- The U.S. natural gas industry is both large and capital intensive. Existing natural gas industry assets total more than $250 billion, including a 1.4 million-mile transmission and distribution system, the vast majority of which is devoted to distribution. The U.S. natural gas industry owns more than 400 underground storage facilities, many of which are located close to end-user markets where the gas is injected during off-peak periods and withdrawn in periods of peak demand. Moreover, the natural gas industry employs more than 150,000 people, a figure that does not include exploration and production employees.

- U.S. consumption of natural gas has increased by roughly 18 percent over the last decade, and demand is expected to increase significantly in the future. This growth has occurred in all sectors of the economy.
- The North American natural gas resource base should prove capable of sustaining current consumption levels well into the 21st century, and perhaps beyond. Policymakers concerned about U.S. energy imports should draw on this secure resource—84 percent of which is produced in the United States, with the balance coming from Canada. Moreover, Mexico has a large natural gas resource base, and its high production capability makes this neighbor to the South a potential major natural gas supplier. In fact, the United States alone is estimated to have more than 60 years of supply at the current rate of domestic supply and consumption.
- Only about 10 percent of the natural gas produced is used or lost during production, processing, transmission, and distribution to the consumer. This gives natural gas a competitive advantage over many other energy sources. Equipment that utilizes gas is also far more efficient today than in the past. For example, gas-fired direct contact water heaters used in the textile industry achieve efficiency levels in excess of 99 percent, compared to a 60 pecent efficiency level acheived using a prior technology. Similarly, new processes have enabled gas-fired infrared burners to triple their efficiency as well. Increased fuel efficiency is another way to improve U.S. energy security.
- Natural gas consumption patterns not only are growing, they are predicted to change significantly. The Energy Information Agency predicts that much of the growing demand will go toward increased electricity generation. Demand from the residential and commercial sectors is also expected to increase, where more new customers are choosing natural gas and more existing customers are switching from other fuels to natural gas. Advances in distributed generation (e.g., reciprocating engines, microturbines, and fuel cells) also are anticipated, and these new technological applications could account for more than 10 percent of all new electricity generating capacity in the coming decades.
- Since natural gas is the fuel of choice among a growing number of central-station generators of electricity, more natural gas pipelines and storage facilities will be built. Natural gas industry leaders will work with federal, state and local officials to ensure that new distribution and storage facilities meet evolving energy security and public safety standards.
- Investment in exploration and production will likely be greater than for the expansion of transmission and distribution systems. To meet projected demand, the number of oil and gas wells drilled per year may have to increase to approximately 34,000 new wells, significantly higher than the average numbers in the past decade. This figure is well below the peak levels of the early 1980s, when from 70,000 to 90,000 new wells were drilled each year. However, the natural gas industry's drilling fleet has aged, and significant investments will be required to upgrade capacity. For example, the National Petroleum Council estimates that about $44 billion per year will be required for oil and gas supply development. However, given our nation's new security concerns, the amount of capital required may be greater—and well worth it, if greater reliance on this domestic fuel helps reduce the nation's overall vulnerability to terrorist attacks on its energy infrastructure.

- Liquefied natural gas (LNG) is an increasingly important part of the U.S. supply, due in large part to technological improvements that have reduced the cost of LNG. Imports of LNG have doubled from 1999 to 2001 and are expected to roughly double again by 2003. In addition, more than 10 new regasification projects have been proposed in the U.S., Bahamas and Mexico that could yet again double the expected 2003 LNG volumes.

POLICY RECOMMENDATIONS

The U.S. natural gas industry operates one of the safest and most reliable gas delivery systems in the world, yet it continues to look for ways to improve both the safety and reliability of its products and its own operations. Following the September 11th attacks, industry leaders developed a list of policies and practices that the industry believes would improve the effectiveness of its security programs, enhance the access to this important domestic resource, and improve its safe and reliable delivery to end-users:

Supply Strategies

- Develop consistent land administration policies and procedures among the numerous federal and state agencies that oversee energy production and development.
- Review and revise federal land-use policies to reflect the positive benefits of new technologies for natural gas exploration and production.
- Address restrictions to natural gas supplies on lands owned by the federal and state governments. Currently more than 200 trillion cubic feet of natural gas are restricted, forcing producers to drill in more costly remote locations. The policies restricting land access have a severe effect on the economics for small producers of natural gas. Opening access to natural gas exploration and production is critical to ensure that we have adequate supplies to meet a growing demand.

Infrastructure Strategies

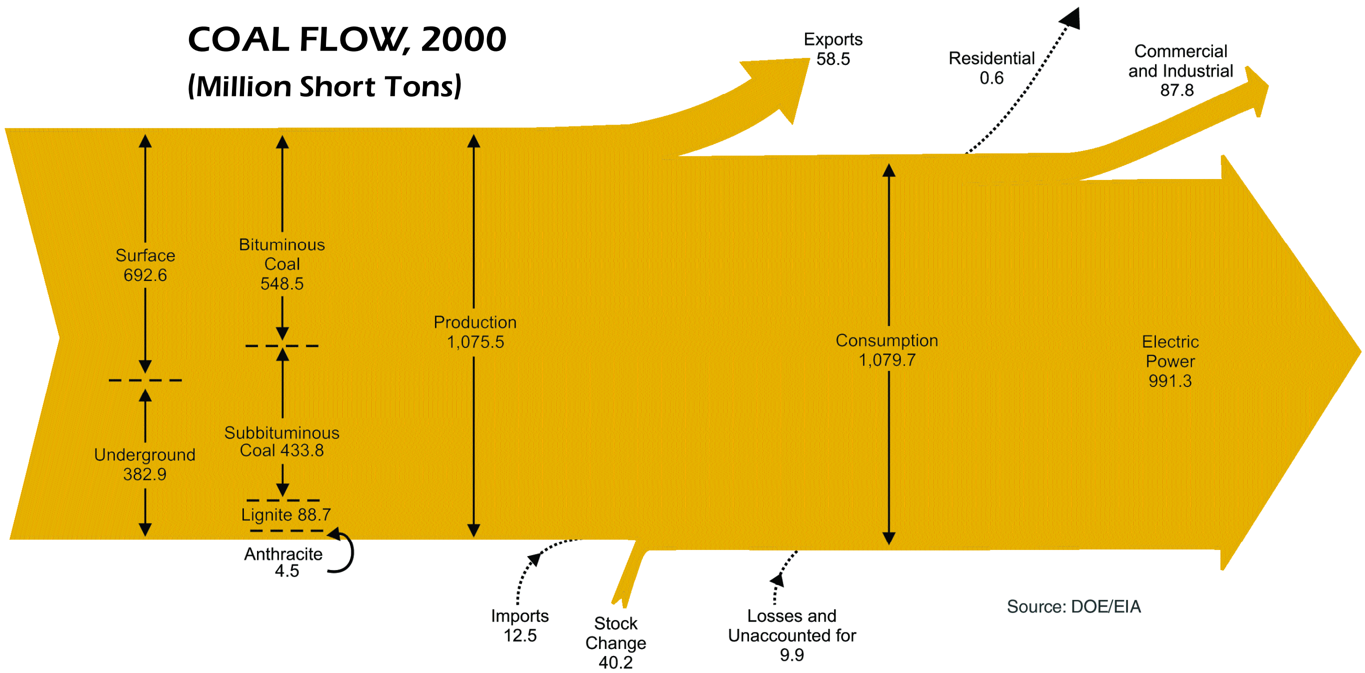
- Establish a research program focused on enhanced safety and reliability of natural gas utility systems nationwide.
- Establish performance-based and risk-based pipeline safety regulations and regulatory alternatives to encourage the use of new, proven technologies and best practices.
- Establish generic procedures to streamline the approval process for pipeline and utility construction projects, and establish stronger regulatory mandates to prevent pipeline damage caused by excavation.
- Remove regulatory roadblocks to infrastructure development, including those for the Alaskan Natural Gas Pipeline.
- Allow new infrastructure construction to be depreciated on an accelerated basis, and allow utilities to meet the increased infrastructure challenges by removing the Contribution In Aid of Construction tax.

Threat Response Strategies

- Assign one government agency the responsibility for oversight and coordination of infrastructure security programs in the energy sector. This approach will ensure that information sharing, alert notification, and responsiveness by our industry will be timely and effective.

- Encourage consistent application across the energy sector by each government agency with jurisdiction over the energy sector (federal and state).
- Establish a common understanding within the federal government of what is expected from natural gas utilities for preparedness and response. The industry is developing response guidelines, but risk levels and critical facilities will be different for each company. Each utility is in the best position to determine its threats and appropriate response. Industry favors general guidelines, not required standards for preparedness.
- Coordinate with all jurisdictions to ensure that access to law enforcement and intelligence information is timely and actionable. Minimize jurisdictional conflicts among government entities through preplanning.
- Establish procedures that allow for reconstruction waivers or permit modifications to expedite response and recovery in the event of terrorist attack.

COAL



OVERVIEW

Coal continues to account for approximately one-third of the United States' primary energy production and for about 23 percent of U.S. energy consumption. Coal is principally used to generate electricity. It also is essential to the production of steel and to other industrial processes, including the production of cement. Coal mined in the United States is exported to other major industrial nations and to many emerging economies, thus contributing to economic development worldwide.

SECURITY OF SUPPLY

Coal remains an affordable and reliable domestic energy source. As such, coal was recognized as an essential component of our domestic energy supply in the Administration's May 2001 National Energy Policy. Coal reserves, which are distributed geographically throughout the United States, comprise the greatest share of the nation's energy resource base. With more than 500 billion tons of demonstrated coal reserve, of which 275 billion tons are economically recoverable using existing technologies, the United States has sufficient coal reserves to meet growing coal demand for well over 200 years.

America already relies heavily on domestic coal to meet its energy needs. In 1990, U.S. coal production first exceeded 1 billion tons annually and production has exceeded that level in every year since 1994. Coal production occurs in three geographically distinct regions: the Appalachian region where approximately 40 percent of coal mined in the U.S. originates, the Interior states of Illinois, Indiana and Western Kentucky, and in Western states where production from Wyoming predominates.

During the past two decades average productivity in the coal industry has increased by nearly 250 percent, reflecting, in part, shifts from underground to surface production and, in part, technological advances in mining operations. This trend is expected to continue as new technologies and more productive mining methods are brought on-line. Advances in technology have not only made U.S. mines safer and more productive, they also have afforded the environment greater protection during the entire mining cycle from exploration and mine development to production to post-mining activities. Whether meeting air or water quality standards, protecting wetlands or reclaiming surface mined land to better than original conditions, coal producers meet and usually exceed all current legal standards.

According to the 2002 *Annual Energy Outlook* of the U.S. DOE/EIA, coal production is expected to increase by some 200 million tons, or by just over 18 percent, by the end of the next decade. In 2010, production is forecast to reach 1.284 billion tons. This entire increase will be used to generate electricity, although coal's share of total electrical generation will decline slightly from its current share of 51 percent. Coal use for steel making, for other industrial purposes and for export is expected to remain relatively stable over the next ten years.

SECURITY OF DISTRIBUTION AND STORAGE FACILITIES

Unlike some forms of energy, coal poses few security issues during the production, distribution or storage stages. Nearly all the coal used in the United States (99 percent) is mined domestically and shipped by either rail or through our waterway system to power generators, steel mills, cement processing facilities, and other industrial users. One commercial slurry pipeline exists, but, because coal is not as combustible as natural gas and petroleum products, transport via pipeline does not offer a very inviting target to terrorists. An issue would arise only if the transportation infrastructure were compromised.

Once delivered to its end-user, most coal storage facilities are part of a utility or industrial complex, where appropriate security measures are in place.

EMERGENCY PREPAREDNESS AND PUBLIC SAFETY

Because coal is a solid, it poses little risk to the surrounding public and would not be a target for terrorists. In the event of an emergency, the coal industry could increase production fairly quickly to meet increased demand for fuel for electricity and would only be hampered by possible transportation constraints.

WHAT LIES AHEAD?

Current production capacity and coal reserves are certainly sufficient to meet the expected demand growth over the next decade. However, to maintain these production levels and to provide additional tons longer-term for domestic and global markets, immediate investments must be made to maintain current coalmine capacity and to expand production beyond the next decade. The development of new mines and the expansion of existing mines are both capital-intensive investments, and both undertakings require lengthy planning horizons.

U.S. coal reserves of 275 billion tons of economically recoverable coal using existing technologies represents a significant portion of America's energy security foundation. The use of these reserves to accommodate some immediate requirements for energy security has been under intensive study. Any U.S. movement toward becoming less energy dependent must place strong emphasis on supplementing petroleum-based fuels with clean fuels from alternative domestic resources.

Coal can be used to make liquid fuels. A group of scientists from both the public and the private sectors are currently examining an initiative which they have termed "The Strategic Defense Fuels Initiative." This response, which is aimed at supplying the need for an alternative domestic-based liquid fuels supply, targeting and satisfying at the outset military customers in the event of the loss or significant disruption of petroleum imports, is now under careful study.

At present, the Department of Defense (DOD) uses about 1.6 percent of total U.S. oil demand (300,000 BPD) and is concerned that in times of limited supply they will not be able to satisfy their liquid fuel needs without severely impacting the U.S. economy. The strategic initiative recognizes that any U.S. movement toward becoming less dependent on foreign sources of energy must place a stronger emphasis on supplementing petroleum-based fuels with clean fuels from a more diverse domestic resource base, including the nation's large coal reserve. The concept, that would use domestic coal for clean fuels production, specifically envisions:

- developing an initial U.S.-based coal to liquid fuels production capacity;
- building the first commercial scale U.S.-based coal fuels plant and specifically allocating its liquid fuel product to military and civilian defense applications; and
- pioneering the use of synthesis gas derived fuels in mobile and stationary applications.

This would involve creating a partnership between the U.S. military, the private coal sector, and the Department of Energy's Fossil Energy/NETL organization for sponsoring the conversion of domestic coal feed stocks to synthesis gas derived fuels. The project would enable U.S. forces to use a clean, sulfur and aromatic-free, high cetane, high performance liquid fuel that can be used in the legacy fleet, in advanced diesel electric hybrids, or which can easily be reformed to hydrogen for use in high efficiency fuel cells. In addition to providing a significant capability for the production of highly needed liquid fuels for the nation's requirements, this process also would enable positive impacts to environmentally sensitive areas.

The production of coal bed methane for a wide spectrum of energy requirements is of additional interest. Methane is the principal constituent of natural gas and is created through the decomposition of organic matter. It is found all over the world in various types of geologic formations, but one of the most abundant sources of methane is found in coal seams. Coal bed methane is removed from coal mines in advance of mining and is often very high quality acceptable for immediate injection into natural gas pipelines.

After the mining process is initiated, methane continues to be liberated from mines as the coal seams are fractured and coal is removed from the mines. For safety, economic and operational reasons, mine operators have focused generally on the most efficient way to remove methane in coal mines by venting rather than capturing and utilizing the gas itself. With technology to accommodate the capture and utilization of the gas now available, what is needed is an incentive for coal operators to invest in these technologies to capture coal mine methane during the mining process and afterwards.

A government tax credit is being proposed as an investment incentive to encourage further safety improvements, the utilization of a currently wasted energy resource, and a significant improvement in air quality in the environment. Government estimates indicate that the establishment of a coal mine methane tax credit of $10 per ton of carbon (which equates to $1.21 per million Btu captured) could reduce the total U.S. greenhouse gas emissions by nearly 1 percent. By using technologies now available to accomplish the capture and utilization of coal mine methane along with an incentive for coal operators to invest in these technologies to capture coal mine methane during the mining process and afterwards, we can realize an increase in the production of methane and also increase production of a national fuel resource. At the same time we can prevent the liberation of a gas that is 21 times more potent as a greenhouse gas than carbon dioxide.

Policymakers would also be wise to consider a number of other relevant issues as they seek to strengthen U.S. energy and national security in the wake of the September 11th attacks:

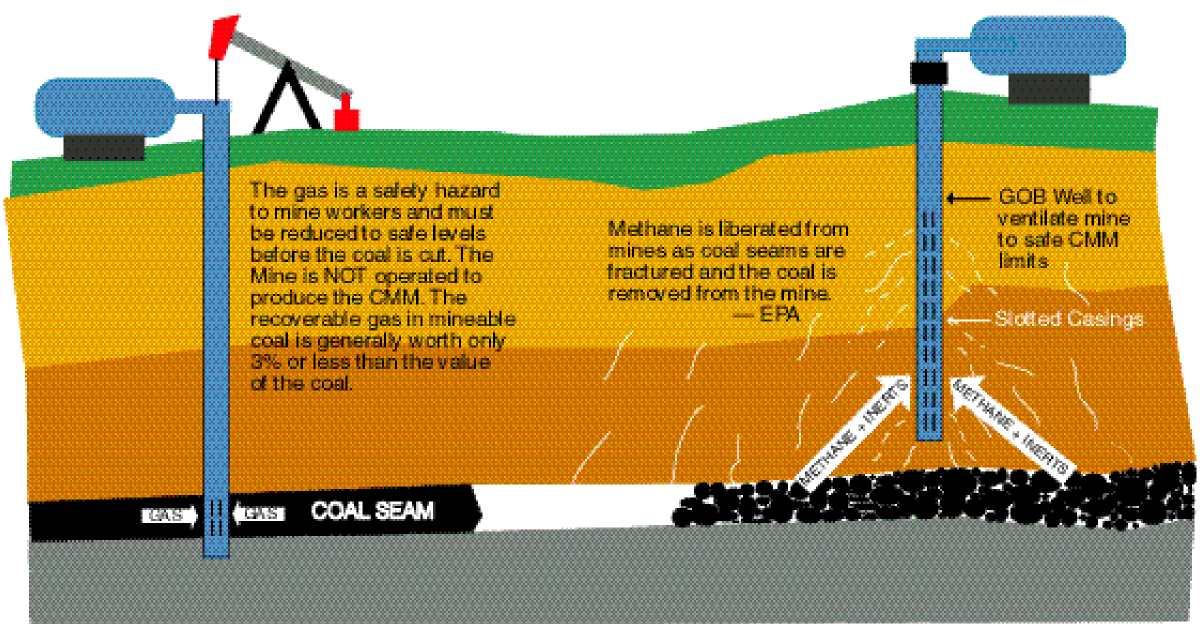
- Because so many coal reserves are located on federal lands, land access policies are extremely important. During the 1990s a large portion of the federal resource base was unfortunately removed from potential exploration and development. Policymakers concerned about U.S. energy and national security should consider developing policies that would return as much of this land as possible to the inventory of lands eligible for coal

COALMINE METHANE EXTRACTION
Inevitably Liberated With Mining and Thus Becomes a Greenhouse Gas

Methane is 21 times more potent a greenhouse gas than carbon dioxide; avoiding its release to the atmosphere can contribute substantially to protection of the global environment.

At least 40% (88 billion cubic feet of CMM per year) could be recovered. This equates to removing almost 8 million cars from the highways.

Methane is removed from coal mines either in advance of mining or during mining activities, exiting the mine through degasification or mine ventilation systems. When removed in advance of mining, the methane is drained through vertical boreholes drilled into the coal seam. This type of CMM recovery often occurs (a few) years ahead of the mining activity. — EPA



exploration and development. This goal can be met while maintaining a sound environment.

- Certain interpretations of Clean Water Act regulations regarding valley fills could threaten to close some existing mines in several Appalachian states. Closure of mines in any region would strain productive capacity in all coal producing areas and would significantly disrupt the coal transportation system.
- The major question facing the coal industry is not whether production can meet higher levels of demand, but whether projected demand will ever materialize. As discussed in the section on electricity, coal-based power plants are subject to over two dozen major Clean Air Act requirements—and likely will face more during the next ten years. The costs associated with these requirements, and the uncertainty about additional regulations to reduce SO_2, NO_x and mercury, continue to discourage construction of new coal-fired power plants, which are needed to meet anticipated demand. Additionally, the EPA interpretation of the New Source Review regulations has essentially prevented maintenance of, or improvements to, existing coal-fired facilities.
- The Administration recently released the "Clear Skies" initiative that would, if enacted into law, cap emissions of SO_2, NO_x and mercury at levels that are much lower than under current law. While challenging, these new emission standards can be achieved while allowing the increased use of coal. However, the imposition of more stringent requirements, or the persistence of a threatening regulatory outlook, will inhibit the growth of coal use for electrical generation.
- Mandatory short-term controls on carbon emissions, that would be required under the Kyoto Protocol, present an even greater danger to the national security and energy security benefits afforded by coal. The United States has wisely stated that it will not be bound by this international treaty, so the near-term threat to expanded coal use has been abated. In fact, the voluntary Climate Change Plan recently put forth by the Administration encourages emissions reductions in a more orderly manner, and does not threaten the use of coal-fired electrical power.
- The proper solution to these policy issues lies in the development and use of advanced technologies. Over the last two decades, the use of new technologies and improved operating practices have improved the "environmental efficiency" per ton of coal consumed by nearly 70 percent. Installation of advanced retrofit and re-powering technologies that enhance environmental performance and efficiency of existing plants will allow this trend to continue.
- Over the longer term, coal's future depends on the use of clean coal technologies that are now, or soon will be, ready for deployment. Limited incentives that offset the technology and financial risks associated with installation of the first of a kind technology are needed to move these new technologies to their commercial or market phase. Given even limited incentives, a number of new clean coal plants could be operational within 10 years.
- Bringing new technologies, including ones that capture and sequester carbon, to the market will be a very capital-intensive, lengthy process. For this reason, the future of coal depends heavily on research programs jointly funded by industry and government. Sustained Federal support of such research initiatives is critical not only to the future of coal, but to the entire U.S. energy industry.

If policy issues—many of which address land use and environmental concerns—are not resolved in a more reasonable manner than now proposed, coal use could remain stagnant or even drop slightly during the next ten years. A decline in domestic coal use is not in America's best interest, especially given the current concerns about energy security and U.S. national security.

POLICY RECOMMENDATIONS

New Technology Deployment

Establish a creative incentive program to attract greater and more rapid investment for new construction, and the renovation and expansion of existing electricity generating plants.

- ▶ Program would stimulate deployment of new and improved technologies that improve operations, improve power generating efficiencies, and decrease environmental impact.
- ▶ Program would expand and improve the use of domestic fuels such as coal and bio mass for production of electricity.

Coal to Liquid Fuels Capability

Develop strategic fuels initiative which produces liquid fuels for U.S. military forces from domestic coal deposits.

- ▶ Assures the availability of military fuels during peacetime and wartime environments.
- ▶ Mitigates the impact of a reduction of imported oil on the U.S. economy.

Expand Federal Lands Inventory

Initiate a study of all Federal lands access policies to determine lands which should be returned to the national inventory of lands eligible for energy exploration and development (coal, gas, oil, nuclear).

Capture and Utilize Coal Mine Methane

A government tax credit is proposed to act as an incentive for mine operators to assist in developing the capability to capture and utilize coal mine methane from the vent-air stream.

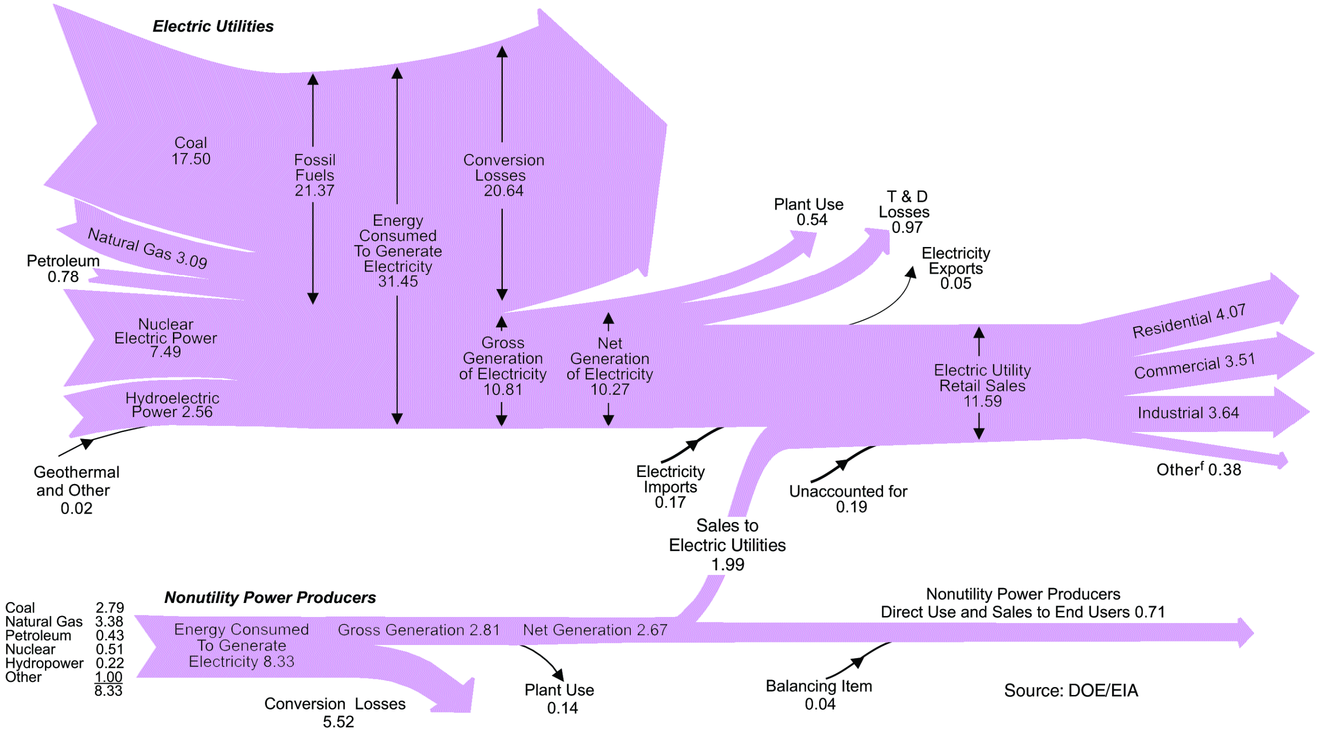
- ▶ Coal mine methane – a domestically available energy source – is conserved rather than wasted, safety is improved, and the environment is cleaner.

Better Educate Americans About Coal Use and Production

Americans do not know about coal – its use, availability, production methods, reserves or potential for future U.S. energy security. Technologies are available to use coal in a variety of national energy needs with minimum environmental impact. A national education program is a must.

ELECTRICITY

ELECTRICITY FLOW, 2000
(Quadrillion Btu)



OVERVIEW

The U.S. economy is increasingly energy-efficient and increasingly dependent on electricity. Electric companies have undergone enormous change during the last 10 years, beginning with the Energy Policy Act that began the transition to competitive markets for electricity. Additional policy and regulatory initiatives are now moving through the White House, Congress, Federal Energy Regulatory Commission and the Environmental Protection Agency, promising even greater change in the future. The resolution of these regulatory and policy issues will have an enormous impact on the nation's electricity markets, U.S. energy security, and the availability of low cost, reliable electricity to end-users who keep our economy vital.

Already, competition among electricity producers has begun to reshape the electricity market. In less than a decade, 14 states, including California, opened their retail electricity markets to competition. In 2001, the District of Columbia and Ohio also launched retail competition programs, and in early 2002, Texas and Virginia joined their growing ranks. However, since early 2000, seven states have chosen to delay their entry into competitive retail electricity markets. Moreover, in the fall of 2001, California suspended retail competition.

SECURITY OF SUPPLY

U.S. electric company executives continue to work closely with federal, state, and local agencies to ensure that the electricity infrastructure remains as safe as possible. Industry leaders are reviewing best practices and policies in the areas of security, information disclosure and insurance. The electric utility industry strongly supports the development of additional transmission capacity. These additional transmission lines—and federal, state and local policies that encourage their construction—give our nation added protection against terrorist attacks and other contingencies.

Even before the September 11th attacks, the Energy Information Administration projected a nearly 2 percent per year increase in electricity demand over the next 10 years. Part of this increased demand will result from innovative uses of electricity that enhance overall productivity and economic growth. Improvements in energy efficiency will keep growth lower than otherwise would be needed. Moreover, EIA's *Annual Energy Outlook* 2002 estimates that an additional 185,000 megawatts of generating capacity will be required to meet the economy's 2010 electricity needs. Natural gas-fired combined-cycle and combustion turbines are expected to account for about 166,000 megawatts of this added capacity. By 2010, natural gas-fired generation is expected to increase 84 percent and account for roughly one-quarter of the nation's electricity production. Coal-fired power plants will continue to meet nearly 50 percent of the nation's electricity needs. Nuclear and renewable resources are expected to meet the remainder of the nation's electricity generation requirements.

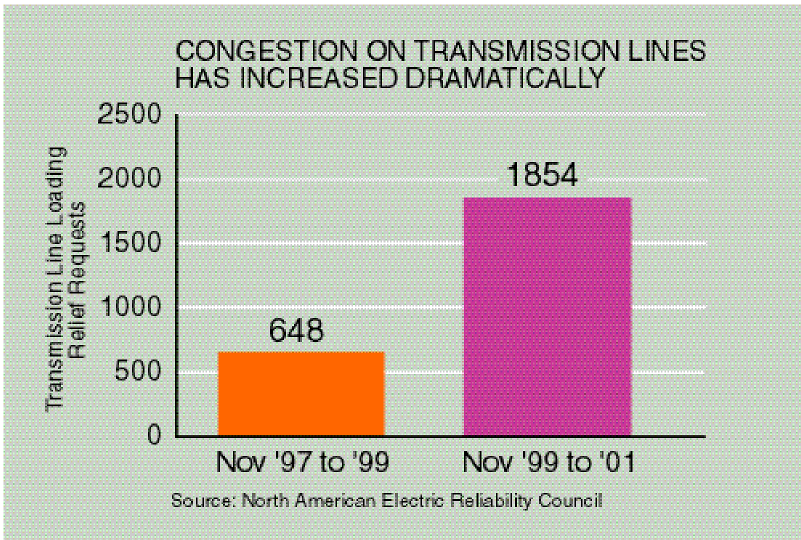
The outlook for consumers is favorable. For example, the average price of electricity, adjusted for inflation, is projected to decline by an average of 0.9 percent per year between year 2000 and 2010 as competition increases among electricity suppliers. Prices in 2010 are projected to be 8 percent, 9 percent, and 7 percent lower than 2000 prices for residential, commercial, and industrial customers, respectively. However, the electric industry will need to overcome several emerging challenges to ensure that EIA's forecast of lower cost and reliable power supplies is achieved.

SECURITY OF ELECTRIC TRANSMISSION

The U.S. electric system comprises an interconnected network of generating plants, transmission lines, and distribution facilities. The electric transmission grid, which currently consists of nearly 160,000 miles of high voltage transmission lines, is in need of expansion and replacement. In fact, the North American Electric Reliability Council (NERC) recently stated that: "The nation is at, or is fast approaching, a crisis stage with respect to the reliability of transmission grids." These integrated regional networks provide electric utilities with alternative power paths when emergencies occur, and allow them to buy and sell power from other power suppliers in order to meet changes in demand at least cost.

The original transmission grid connected neighboring utilities in order to ensure reliable service. Now it is used as a "super-highway" for electric companies who "wheel", or move, electricity from one area of the country to another. This increased flow of electricity across ever-greater distances has created significant and costly congestion. For example, between November 1999 and October 2001, transmission congestion grew by more than 180 percent, when compared to the previous 24-month period. This transmission gridlock constrains low-cost marketplace transactions because electric power cannot be physically transmitted from sellers to buyers.

The Federal Energy Regulatory Commission (FERC) recently identified several causes of transmission congestion. In some cases, regions simply do not have sufficient transmission capacity to meet demand. In other areas, too few transmission lines exist to match the electricity generated that companies want to sell. FERC analysts estimate that, in all, $12.6 billion in new transmission investment will be needed to overcome 16 major transmission bottlenecks around the country. These same analysts agree that once these transmission investments are made, customers will likely realize significant cost savings. Conversely, higher electricity prices and reliability problems will persist if transmission congestion continues to intensify.



This may well happen. The Energy Information Administration projects that electricity use will increase 22 percent by 2010. Additions to the transmission grid, on the other hand, are expected to be slow during this same period. According to NERC analysts, the number of circuit miles of high voltage transmission lines is likely to increase a total of only 4.2 percent compared to U.S. electricity demand that likely will rise around 2 percent per year during these same ten years. Moreover, the needed transmission lines will only be built if those who invest in their construction receive an adequate return on their investments. Unfortunately, during the past two decades annual investment in new transmission has actually declined some $100 million a year, when the dollars invested are adjusted for inflation.

EMERGENCY PREPAREDNESS AND PUBLIC SAFETY

The electric utility industry has a long and distinguished record of responding to—and quickly rebuilding from—all kinds of natural disasters. Prior to the turn of the millennium, the industry spent considerable time and resources looking at every aspect of electric system disaster recovery, including both cyber and physical security, as well as developing the means to locate and correct disturbances throughout the system.

This experience has allowed the industry to move forward with confidence to meet the challenges it now faces. A broad-based coalition has formed, modeled after the preparations for “Y2K,” to ensure the greatest possible government and industry coordination of infrastructure security preparations and contingency plans.

The industry remains in a heightened state of alert and readiness. In order to deal with possible future events, the industry is reviewing all of its relevant processes and procedures. The responsibility of reliably providing a service upon which all of modern society and industry depends is taken very seriously.

WHAT LIES AHEAD?

The U.S. electricity industry faces a number of national energy security challenges, many that federal, state and local policymakers can help alleviate. Doing so would be in the nation's, as well as the industry's and consumer's, best interests. For example, creating policies that attract capital for the construction of additional transmission lines would both lower long-term electricity prices to consumers and increase the number of power paths available to utility operators in the event of a man-made or natural emergency. Here are some additional challenges:

- Siting new transmission is extremely difficult. FERC officials have strong federal authority when siting natural gas pipelines, but states currently determine where electricity transmission lines will be sited. This process can lead to long delays, especially if several states are involved. Moreover, obtaining regulatory approvals for transmission projects is extremely complex and often leads to costly delays. Some new transmission projects are rejected outright. America must build new transmission facilities and upgrade existing facilities in order to keep the current system reliable and meet future demand. Only when these additional lines are in place will the expected benefits of wholesale competition be realized and the nation's electricity supplies made more secure through redundancy.
- FERC officials have begun to move forward on several rulemakings, including the so-called "GigaNOPR" proposal, which seek to standardize the design of wholesale electricity markets, nationwide. The formation of regional transmission organizations (RTOs), as directed by Order No. 2000, is key to FERC's strategy. However, in practice, RTOs may take quite different forms. For example, an independent system operator (ISO), which is independent from transmission owners and other market participants, does not own the facilities that it operates. By contrast, independent transmission companies (ITCs) are for-profit entities that own the facilities they operate but are also independent of the market participants who use the system.
- Many believe ITCs can encourage efficient transmission services and provide incentives for owners to invest in new transmission facilities thereby reducing congestion costs borne by consumers. However, under current tax laws, transmission-owning utilities that sell or spin off their transmission assets to form ITCs would incur substantial federal income tax liability.
- Other transitional tax issues that prevent participation in RTOs include "private use" restrictions embodied in the federal tax code that inhibit public power systems from providing access to their existing transmission lines and financing new facilities to strengthen the grid and serve their communities. Rural electric cooperatives also face several tax impediments to electric competition that necessitates updating federal tax law. Congress should enact a complete package of tax modernization measures to provide solutions to enhance the development and delivery of energy supplies which are consistent with the public policy directives of FERC to form RTOs.
- The electric utility industry continues to improve its environmental performance. Despite the growing demand for electricity and increased generation from coal, Environmental Protection Agency data show that air quality has improved during the past 30 years in no small way due to technological advances by power generators. In fact, control programs already in place will reduce NO_x and SO_2 emissions by 40 percent

and 50 percent, respectively, from their previous high levels. These and other programs are reducing mercury emissions by 40 percent.

With the addition of new EPA emission reduction programs, companies face a large number of duplicative and uncoordinated air quality regulations. The efficiency in making these reductions can be improved, however. Alternative policy options are being explored that will enable electricity suppliers to meet our nation's environmental goals more cost effectively, with more flexibility and with greater certainty, thus ensuring the reliable flow of electricity while benefiting the environment.

Conversely, some are advocating policies that will obstruct the efficiency of environmental regulation by adding a new layer of emission controls, including significant carbon reductions, and by opposing reform of EPA's broken new source review (NSR) program. If such efforts are successful and new emission regulations raise the cost of coal-fired electricity generation significantly, electricity price and national security issues are sure to surface.

Thanks to fuel diversity—the ability of electric generators to choose among various energy sources—this country's electrical supply is less susceptible to disruption or supply problems than would be the case if we relied on a single fuel source. Electrical generators make use of coal, nuclear power, natural gas, fuel oil, hydroelectric dams and other renewable sources of energy. While the mix of fuels used to generate electricity varies from region to region, on a national average, very little of our electricity is generated using imported oil. The diversity of our fuel supply is one of the electric industry's greatest strengths.

POLICY RECOMMENDATIONS

Enhancing the existing electricity transmission network is vital if our nation's electricity system is to continue its critical role in the American economy. Barriers that currently stand in the way of expanding system capacity to provide redundancy and meet present and future demand must be removed, and laws that limit rapid response to potential crises must be amended. Policymakers must remove federal barriers to competition, update our tax laws, provide the incentives to encourage needed investment in our electric infrastructure, and allow market forces to shape regional energy markets.

Fuel Diversity and Supply

No individual fuel is capable of providing the energy to meet all of our nation's electricity demands. Rather, a diversity of supply options is key to affordable and reliable electricity.

- Policymakers and regulators need to work together to reconcile conflicting energy, environmental, and other public policy goals in order to capitalize on our nation's abundant natural resources and address challenges that now limit the development and viability of numerous fuel sources.

Electricity System Reliability and Redundancy

The U.S. bulk power transmission system is under increased stress due to changes in the wholesale and retail electricity markets. Inadequate generating capacity, congested transmission lines, and transmission chokepoints can become points of serious system security vulnerability. It is critical for America's energy security that existing generating capacity is maintained, construction of new generating capacity is expedited, and the transmission system is expanded to meet growing demands.

Congressional action is needed to:

- Give FERC backstop authority to help site new transmission lines if states cannot or will not approve new transmission projects.
- Streamline the permitting and siting process for transmission lines that cross federal lands.
- Establish a self-regulating reliability organization, with FERC oversight, to develop and enforce binding reliability rules and standards. Enforceable "rules of the road" governing the operation of the bulk power transmission system will improve the reliability and security of the nation's transmission system.
- Encourage FERC to ensure adequate investment returns that will attract the necessary capital investment in the electric transmission system.

Changes to the U.S. Tax Code

Currently, many outdated tax laws hinder the development of critical new electric infrastructure, and should be removed or updated. Congressional action is needed to:

- Remove impediments to the sale or spin-off of transmission assets to FERC-approved RTOs. FERC is calling for the "unbundling" of electric transmission assets held by vertically integrated utilities, ultimately placing these assets under the control of RTOs. Under current tax laws, transmission-owning utilities that sell or spin-off their transmission assets would incur substantial federal income tax liabilities to facilitate the transition to RTOs.
- Amend nuclear decommissioning tax law to facilitate the transfer of nuclear assets.
- Provide "private use" relief for tax exempt bonds of state and locally owned electric utilities and eliminate tax impediments faced by rural electric cooperatives that inhibit full participation in emerging competitive markets.
- Allow enhanced accelerated depreciation for property used in the transmission or generation of electricity.
- Repeal the Contributions In Aid of Construction (CIAC) tax.

Critical Infrastructure Security

- Voluntary industry-wide and private-public information sharing programs would enhance critical infrastructure protection in the private sector. However, steps should be taken to ensure that highly sensitive information not be compromised or allowed to fall into the wrong hands. To accomplish this, limited, specific exemptions from the Freedom of Information Act (FOIA) for certain sensitive information shared by the private sector with the federal government should be provided.
- Private insurance coverage for the effects of terrorist attacks may no longer be affordable or even available. Insurers are already adding new terrorism exclusions to utility property and liability insurance policies. The federal government should create a public-private insurance backstop for extraordinary catastrophes, such as terrorist attacks.
- Current laws limit eligibility for Federal Emergency Management Agency (FEMA) disaster recovery assistance aid to municipally owned utilities and electric cooperatives. Disaster recovery assistance needs to apply to all types of utilities, including shareholder-owned utilities.

- ▶ Current laws and regulations limit the deployment of utility resources — including labor, vehicles, and equipment—during declared emergencies and during subsequent restoration and repair efforts. This affects the ability of utility crews to address public safety concerns and to fully restore critical infrastructure systems. Public utilities need to be exempted from these restrictions.

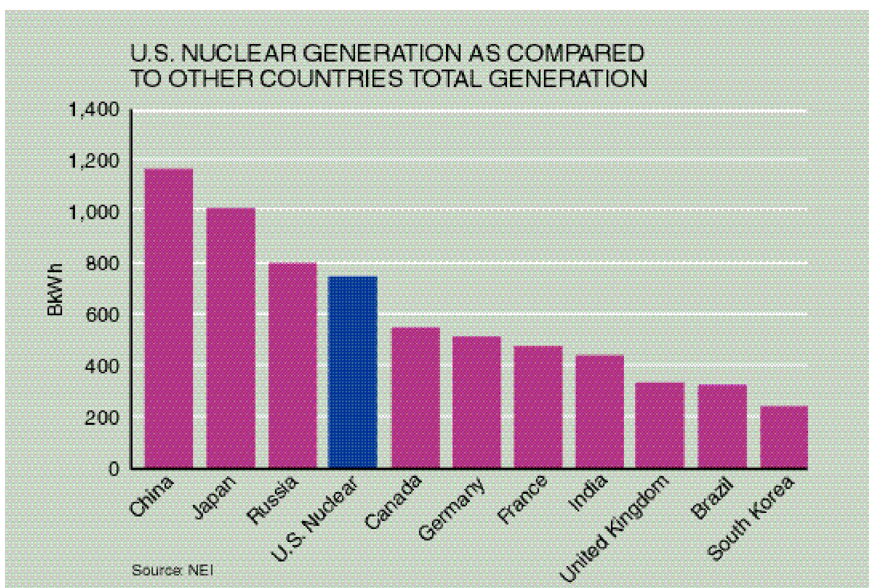
NUCLEAR ENERGY

OVERVIEW

Nuclear energy contributes significantly to the diversity and independence of the nation's energy mix. At 20 percent of the U.S. electricity supply, the nuclear program in the United States is the largest, most mature and most efficient in the world. Commercial reactors in the United States produce more electricity than is required to meet the total electric demand in all but three countries in the world. Moreover, this vital energy source uses a fuel that is abundantly available domestically. It contributes to national energy security in many other ways as well. It is the lowest cost source of all expandable methods of electricity generation. It is reliable, owing to the standards of excellence in operations, and it is very stably priced because of the nature of the nuclear fuel cycle. It is an instrument of national policy in converting excess supplies of weapons materials to peaceful and essential electricity. Enormous amounts of energy are generated from minute quantities of fuel. This minimizes waste issues and, because used nuclear fuel is solid, it is easily managed. Nuclear energy produces no greenhouse gas or other detrimental airborne emissions. This makes it essential to our air quality goals, such as the Clean Air Act, and well suited to use in areas of high-energy use that would otherwise be limited by clean air constraints.

SECURITY OF SUPPLIES

Nuclear fuel is adequately abundant in North American ore deposits, and is expected to meet current and projected needs during the next 10 years. Nuclear fuel is obtained by mining uranium ore from the earth, converting it to a chemical form suitable for enrichment, and then further processing into a form ready for fuel fabrication. (Enrichment is the process of increasing the amount of uranium isotope U235 from its naturally occurring level of 0.72% to a higher level, typically about 4% to 5% for reactor fuel. Weapons grade uranium is very highly enriched to greater than 90% U235.) Each of these steps—mining, conversion, enrichment and fabrication—is at a different level of relative domestic independence. Mining, conversion and fuel fabrication are straightforward industrial processes. Enrichment capability, which is somewhat unique, will be discussed in greater detail later from the viewpoint of energy independence and energy security.



The current price of uranium, through all stages of processing to finished nuclear fuel, is relatively low for a variety of reasons. By international agreement, significant quantities of uranium enriched to weapons grade are being diverted from weapons stockpiles to use in commercial reactors. Because weapons grade material is highly enriched, the process of making commercial nuclear fuel is known as "down blending." Small quantities of weapons grade material can produce large quantities of reactor fuel by dilution with natural uranium. Market values, avoided production costs and foreign policy considerations are the price mechanisms that hold prices down and diminish the need for mining uranium ore. Fewer mines are in operation, and market prices currently discourage exploration and development of new reserves.

Reactors are also capable of consuming plutonium produced for weapons or recovered from reprocessing used reactor fuel. Fuel containing both plutonium and uranium is called mixed oxide (MO_x). Some U.S. commercial reactors are preparing to use MO_x fuel produced from weapons plutonium on a controlled basis. If this practice proves desirable from a policy viewpoint, reliance on mined uranium will be further reduced or delayed.

Other potential sources for reactor fuel also exist, although none is expected to be used in the near future. However, the availability of these options demonstrates that nuclear energy offers a long-term prospect of fuel independence. For example, used reactor fuel can be reprocessed. During reprocessing, portions of used fuel that are waste products are separated from usable remaining uranium and plutonium produced in the fuel during operation. Reprocessing is not practiced in the United States for policy reasons involving non-proliferation and as a practical matter because the prices for new fuel from ore or from weapons inventories are less expensive alternatives. Nevertheless, all existing inventories of stored used nuclear fuel contain a substantial amount of energy that can be recovered if the nation makes the investment in reprocessing technology or decides to use a foreign source for this service. Reprocessing is practiced in Europe and Asia, where natural resources for energy production are less abundant.

Reactors can also be designed to operate on fuels other than uranium or plutonium. In some cases these other fuels such as thorium are even more abundant than uranium and may also be beneficial for non-proliferation reasons. Finally, reactors can be designed that produce more fuel than they consume in the process of producing electricity. These are called breeder reactors. Development of reprocessing, alternate fuel cycles and breeder applications are appropriate subjects for research supporting energy independence in the longer term. None of these possibilities can influence U.S. energy independence in the next 10 years.

The U.S. is dependent on foreign sources for enrichment services. The unit of measure of enrichment service is the separative work unit (swu). Reactor operation at current levels requires about 12 million swu per year. Domestic enrichment capability is limited to about 8 million swu on an economic basis and to about 11 million swu if total capacity is considered. Notably, there are substantial differences in enrichment technology employed domestically and by foreign producers of enrichment services. In the U.S. the enrichment process known as gaseous diffusion is used. This is a legacy technology dating to the early years of commercial nuclear power plants. More efficient techniques are used abroad, including centrifuge technology. Expansion of capacity to meet domestic needs would require reconsideration of current policy decisions, i.e. use of enriched weapons inventories, and a substantial capital investment in new technology.

In summary, most aspects of the process of furnishing fuel to reactors are available domestically. Where a non-U.S. dependency exists, it is the result of government policy. In the case of enrichment services, the situation is somewhat analogous to petroleum refining. Enrichment is a fundamental strategic service relative to nuclear energy. To allow enrichment capacity to fall below domestic needs encumbers the notion of energy independence for nuclear energy. On the other hand, the presence of weapons material inventories and the fact that foreign enrichment services are available from nations closely aligned with the United States makes this risk amenable to deliberate policy activity on the part of the government and commercial enrichment service providers. This policy activity must fully consider the fact that increased enrichment capability requires long-term planning and significant investment.

SECURITY OF STORAGE AND DISTRIBUTION FACILITIES

Secure and reliable supplies of nuclear fuel exist for power production and refueling. Most nuclear-powered utilities are refueled every 18 to 24 months, and ample supplies of nuclear fuel are available to meet this demand. Typically, refueling is scheduled months in advance and takes place during periods of low electrical demand, as when moderate weather conditions prevail. The long refueling interval, coupled with the fact that only a portion of the fuel in the reactor is replaced at each refueling, provides price security as well. The cycle also permits fuel purchases based on long term, economically priced contracts. Nuclear fuel is relatively inexpensive, stable in price and not subject to the volatility of commodity fuels.

Constraints in the distribution and transmission systems for the electricity generated have a generally deleterious effect on energy security and reliability. The constraints and their general impact are discussed in detail elsewhere in the report. Nuclear energy is affected in some relatively unique ways. The current generation of nuclear power plants average about 1,000 MW each in size and operate most efficiently when operated at steady full power. As such they are ideally suited as baseload generating capacity for regions of the country characterized by high economic output and high population density. The deployment of new nuclear plants can be constrained by inadequate ability to economically deliver the output of large new baseload facilities outside the local region. Investment in improved transmission capability will improve national energy security no matter what the fuel source.

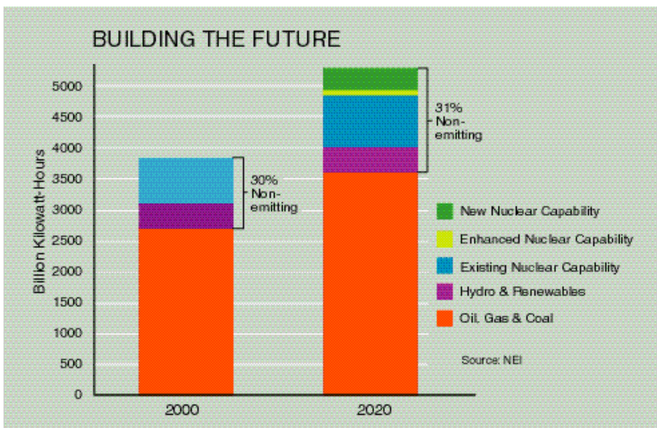
Storage of the very small quantities of used fuel generated relative to the amount of energy produced is not a complex technical issue. At present this solid used fuel is stored very safely at each of the facilities where it was used. It is secure in robust buildings and containers. It is isolated from the environment and fully accounted for. As a matter of public policy, the Congress decided in 1982 that a central repository for used fuel was in the national interest. The President has recently recommended a site after 20 years of exhaustive study at Yucca Mountain in the Nevada desert for this purpose. The repository should be licensed and built by 2010, and when completed, will further enhance the security of used nuclear fuel.

EMERGENCY PREPAREDNESS AND PUBLIC SAFETY

Nuclear power plants have a five decade history of safety and security that is unparalleled in the energy sector. They are among the most heavily defended commercial facilities in the United States. For nearly a quarter century, federal regulations have required that the plants provide a security force capable of resisting a terrorist land assault, assisted by insider support. The ability to meet these requirements has been demonstrated and tested by on-site combat exercises. In addition, the structures housing the reactor and on-site fuel storage are exceptionally robust. Reactor containments are designed to withstand severe natural phenomena and in some cases were designed to withstand the impact of aircraft serving regional airports at the time the plants were designed.

Nuclear power plants also have extensive emergency plans capable of coordinating the services of local, state and federal agencies to assist and protect the public. These mature plans have been exercised at least annually at every nuclear facility for over 20 years. Although they have never been required to be used for a civil evacuation because of a nuclear plant emergency, they have been used and found very effective in response to other public emergency situations such as toxic chemical spills.

The terrorist attacks committed on September 11, 2001 have raised widespread concern about the physical security of all critical infrastructure and some very specific concerns about potential danger involving nuclear power plants. Nuclear facilities, like other critical infrastructure, were not designed to withstand acts of war and their security forces are not a substitute for the military capability of the United States.



Some individuals and groups have attempted to leverage public concern arising from the September 11th attacks to further an anti-nuclear agenda. They have suggested that if an attack similar to the ones of September 11th were directed at a nuclear plant, tens or hundreds of thousands of deaths from radiological disaster would occur. These same organizations have asserted that nuclear security forces are woefully deficient. These assertions are simply not true. The nuclear industry and its regulator, the Nuclear Regulatory Commission, promptly implemented some security enhancements after September 11th to account for the new threat environment. With these changes, nuclear power plants remain among the most secure and protected commercial facilities in the nation just as they were before September 11th.

However, nuclear plants and other elements of critical infrastructure are not designed to withstand acts of war. Nor should they be. It is imperative that the physical security of critical infrastructure receive a coordinated assessment at the federal level to determine what should be protected, how it will be protected and what the dividing line between the responsibilities of commercial enterprise and the government is with respect to attacks by terrorists or other acts of war.

WHAT LIES AHEAD?

The nuclear industry in the United States responded to the Administration's Energy Policy with its own document, VISION 2020. Simply stated, the industry intends to grow the current supply of nuclear generated electricity such that by 2020, the portion of non-emitting electricity generation remains constant. Increased efficiency, license renewal of existing nuclear plants and the construction of sufficient new capacity to keep nuclear energy's contribution proportional to the current mix are the keys to realizing this vision. VISION 2020 also promotes recognition that nuclear energy can be a clean source of alternate clean fuels, such as hydrogen, and in that way help meet future energy needs.

Growth of nuclear energy with the growth in demand for electricity to maintain the portion of nuclear energy today is not assured. If nuclear energy does not grow in proportion to national demand, overall U.S. energy security will be diminished. Nuclear generating stations provide fuel diversity, which is important to energy security. Nuclear-generated electricity also constrains price volatility because nuclear-generated electricity is consistently produced at a stable, low-cost rate. Furthermore, because nuclear power plants emit zero pollutants, other plants that do emit gases and particulates can still be built nearby without exceeding local pollution limits.

Factors that influence the ability of the nuclear power industry to keep pace with national demand, and thus maintain a diverse energy mix in the electricity sector, are the same factors that affect all generation and energy infrastructures, regardless of the fuel used. These factors include:

- ▶ Sufficient capital to undertake long-term infrastructure projects.
- ▶ Sufficient workforce to construct and operate the facilities.
- ▶ Maximum independence for all facets of the fuel supply.
- ▶ Ability to site new plants and facilities efficiently.
- ▶ Enhanced transmission and distribution infrastructure.
- ▶ Accurate price signals for the proper allocation of resources.
- ▶ Clear division of responsibility for physical security.

All of these factors are needed to create a sound national energy policy. Moreover, a sound energy security policy will address such issues as physical security, independence from geo-political disturbances, reliability and adequacy of supply, price stability and compatibility of energy generation and use with the environment. Some argue that energy security requires total self-reliance. This is not the case. If energy self-reliance is not possible, security is still possible so long as no hostile power is capable of exercising control over domestic energy production and use. Some argue that energy security depends solely on increasing proven resources and supplies. This is not true either. Conservation, energy efficiency gains and the expansion of renewable energy resources can also enhance energy security. Still others argue that controlling demand and substituting new forms of generation for existing energy supplies will ensure energy security. It will not do so. Energy security will be achieved only when policymakers recognize that the nation needs all of these measures to meet the growing demand for energy in our vital nation.

POLICY RECOMMENDATIONS

- ▶ A clear division of responsibility must be achieved to balance and delineate the responsibilities of the private sector and public sector for defense against acts of war and terrorist activity for all energy infrastructure.

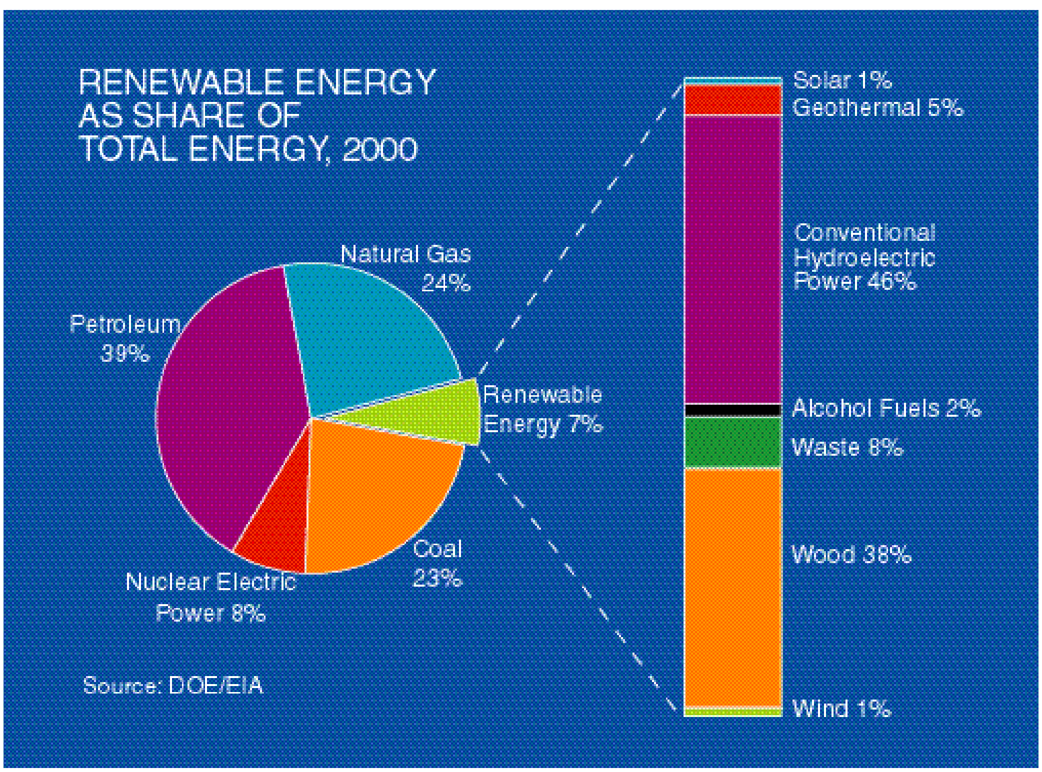
- A long-term program must be established to maintain adequate competitive and modern domestic enrichment capability for nuclear fuel.
- A research program leading to effective new fission fuels that are proliferation resistant must be undertaken.
- Federal policies must be undertaken to encourage investment in the physical and human capital necessary to support long-term energy infrastructure.
- Economic recognition for nuclear energy's non emitting character should be provided in proportion to the economic value of allowances provided to emitting technologies.
- A system of credits should be provided for emission avoidance to non emitting sources of generation equivalent to allowances for emission releases.

RENEWABLE ENERGY

OVERVIEW

Renewable energy sources such as biomass, geothermal energy, wind and solar power make up 4 percent of U.S. energy production. Hydropower adds another 3 percent. These relatively low numbers reflect the fact that renewable energy technologies are not uniformly mature or competitive with fossil fuels in most situations. Moreover, renewable energy supplies cannot be generated and/or stored in sufficient quantity to reliably meet demand during emergency times. However, price and performance of renewable energy technologies continues to improve. The events of September 11th have spurred policymakers to examine the national security merits and vulnerabilities of all U.S. energy supplies, including the energy security attributes of renewable energy. For example, renewable energy sources:

- Provide a clean, domestic source of energy;
- Offer standby or emergency electric power by enabling customers to generate their own power;
- Support electric distribution systems by placing generation at weak or distant points of the grid;
- Sometimes enable generators/users to avoid expensive transmission and distribution lines that are required by central-station power plants; and



- Broaden the mix of electricity sources, which helps make the United States less vulnerable to supply interruptions.

SECURITY OF SUPPLY

Geothermal Energy from below the Earth's surface can be converted, using turbines, into electricity or circulated through pipes to heat buildings. However, naturally occurring geothermal fields are relatively few, and many are located in parks or on federally protected lands, so their use is limited. In recent years, however, technology has made possible small-scale heat pumps capable of heating and cooling a typical house. Costs are still high relative to standard heating systems, but once the initial investment is made, the supply of heat can be reliable and constant.

Solar Energy is harnessed by photovoltaics (PV), solid-state semiconductor devices and applications include rooftop residential power systems and utility-scale bulk generators. During normal operations, they can help meet electricity needs when demand is high on very hot sunny days. However, solar power is dependent on the availability of sunlight and generating and storage capacity are both limited.

Wind Energy has made substantial progress during the past several decades with gains in efficiency and reductions in the cost of a kilowatt hour of electricity generated. New variable-speed wind plants currently deliver power at prices that are approaching conventionally generated electricity. However, wind energy, like solar energy, is dependent on nature. Moreover, windmill farms pose bird habitat problems, require large areas of land to generate significant amounts of electricity and maintenance costs are high.

Biomass or Bioenergy relies on organic matter to generate electricity. Today, the most frequently used biomass is wood, but other sources—including plants, residues from agriculture or forestry, organic components of municipal and industrial wastes and fumes from landfills—are being explored and, in some cases, used on a daily basis. However, several critical challenges remain. First, supplies may not always be available, either because of seasonal changes or because of geographic location. Second, bioenergy is less energy-dense by volume than fossil fuels, so greater amounts of biomass are required to generate the same amount of power. Finally, few communities would welcome the storage or processing of large quantities of organic matter, industrial waste or landfills, so generating facilities are often located a considerable distance from the end-user.

Hydropower or Hydroelectric Power is the production of electricity by waterpower and is well established and cost competitive in the United States. Hydropower facilities range in size from 1000 megawatts to 10-20 megawatts or even smaller. Like solar and wind power, hydropower is dependent on nature (rainfall) and, like other renewable energy sources, faces the challenge of low-cost, efficient storage.

INFRASTRUCTURE RELIABILITY

Reliability of supply and reliability of the electric system are two separate but complimentary issues. The reliability of electric systems is critical to U.S. economic activity, and actions that threaten to reduce the reliability of the overall system can seriously disrupt daily life and damage economic activity, regardless of whether the infrastructure is attacked by terrorists, disrupted by a major storm, or slowly eroded by poor planning or poor policies. Currently, reliability issues are largely addressed by requiring that central generating plants maintain a certain level of reserve generating and transmission capacity. However, these reserve margins have declined in recent years as electricity deregulation has taken hold in the marketplace. Additionally, transmission and distribution infrastructures are overburdened, fragile, or altogether absent in some parts of the United States, so policymakers face an on-going challenge regardless of the likelihood of terrorist attacks.

As noted above, some renewable energy sources are modular and can be distributed throughout the grid in such way as to enhance transmission reliability and provide a source of back up power. For instance, PV solar cells can support distribution systems by placing generation at weak or distant points of the grid. Wind turbines can also support overextended distribution lines, or support load centers. The robustness of the electricity grid can be further enhanced through net metering—the ability to sell unused energy back to the utility—and by niche marketing—primarily, to residential customers.

WHAT LIES AHEAD?

In order for renewable energy resources to penetrate the U.S. energy market in a substantial manner, most renewables must become more cost competitive. Others will not gain greater acceptance until electric storage capacity is vastly improved. And regardless of the technical advances, which are many and promising, the capital costs remain huge to move a nation as large, and an economy as energy-intensive as ours, from fossil fuels to renewable energy supplies. In most instances, government mandated rules, subsidies, and other inducements will be needed in the foreseeable future to accelerate the use of renewable energy supplies.

Hydroelectric power faces a slightly different challenge. While its environmental benefits are clear (no emissions), there are no promising available sites in the U.S. for new large scale hydroelectric projects. Furthermore, existing and new sites for small scale hydro projects are subject to significant environmental restrictions. In fact, it takes 8 to 10 years to gain a hydroelectric license—and relicensing can result in a substantial loss of generating capacity due to newly imposed environmental restrictions. Given these conditions, few investors are willing to risk capital on new hydropower development projects.

POLICY RECOMMENDATIONS

- Review existing energy infrastructure systems and patterns of supply and consumption in order to assure the system is as secure as possible, and deploy renewable energy supplies where needed.
- Lessen the burden of environmental and land use regulations, licensing and permitting requirements.
- Look for solutions that are consistent with energy security, environmental and economic policies, including voluntary climate change initiatives.
- Increase tax incentives for investments in renewable technology.
- Undertake broad public efforts to promote renewables and encourage the efficient use of energy.

- Eliminate regulatory policies that impose a cost penalty on the intermittency of many renewable technologies.
- Increase renewable energy R&D initiatives all across the board, from basic science to commercial application.
- Identify potential barriers to the deployment of increased dependence on domestically-produced renewable energy resources.

V. Energy Efficiency and Conservation

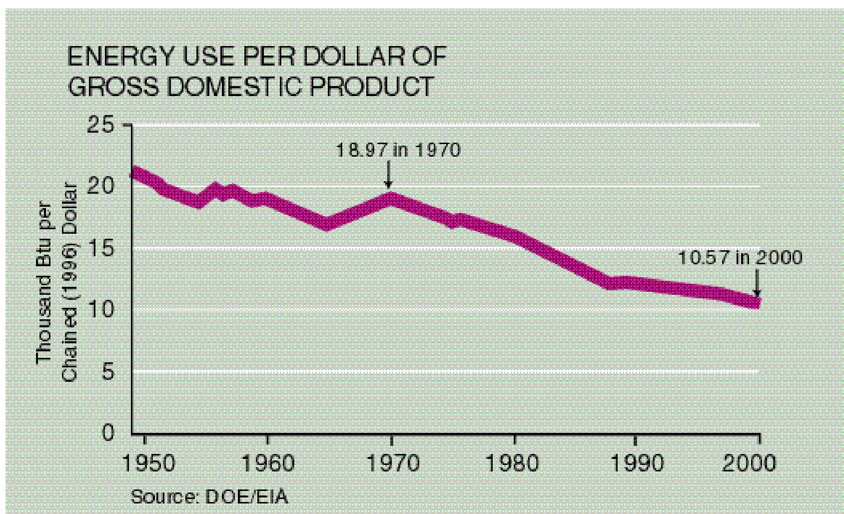
OVERVIEW

Energy efficiency gains and energy conservation have already contributed significantly to U.S. energy security, and promise to do more in the future, both in the United States and for economies throughout the globe. That is because both energy efficiency and energy conservation encourage the prudent use of existing energy resources, reduce energy imports and help limit the impact of energy production and consumption on the environment.

Government officials and agencies can promote energy efficiency through long-term energy research and development, improved information dissemination, establishing realistic efficiency standards and by taking the lead in reducing energy consumption in government facilities.

The United States has made significant improvements in energy efficiency. Since 1973 the U.S. economy has grown by 124 percent and energy consumption has grown by only 26 percent. Technology exists that will enable energy produces and end-users to achieve even greater energy efficiency gains, though considerable capital investment will be needed to realize many of these gains.

Energy price signals are fundamental to consumer choice and improved energy efficiency. Consumers will make rational economic decisions when they are supplied with accurate and timely price signals. Otherwise they may not have the incentive to select the most energy efficient products.



SECURITY OF SUPPLY

The end-user generally controls energy conservation, so the "security of conservation supply" often rests with the individual consumer. For example, homeowners can turn down their furnace thermostat in the winter, and turn up their air conditioner thermostat in the summer. Timed devices can achieve the same, or greater, energy savings in the home, just as operating a car on cruise control when highway conditions permit can increase the fuel efficiency of an automobile.

On the other hand, advances in technology are often the key to substantial energy efficiency gains. For example, on-board computers regulate the flow of fuel into most automobile engines, a far more efficient way to distribute fuel among the cylinders than the manually operated carburetors found in older cars. Similar gains have been realized in industrial processes, manufacturing, bulk transport, electric generation efficiency, and many other aspects of the economy. Again, technological advances are the key to further energy-efficiency gains, much as personal decisions and habits are often instrumental to energy conservation.

The bottom line is that reduced energy consumption per unit of goods or services helps U.S. energy security in two ways: it reduces energy imports and cuts the overall cost of finding, developing and transporting the many sources of energy on which our society and our economy rest.

WHAT LIES AHEAD?

Long term, the U.S. Energy Information Administration projects continuing efficiency gains. Advanced electronic controls, for example, are expected to offer even greater operational gains in the residential, commercial and industrial sectors. Hybrid vehicles and hydrogen fuel cells may also significantly improve transportation efficiency. Moreover, cogeneration of electricity and the productive use of waste heat from electricity generation are also expected to be two big energy savers in the decades ahead. More specifically, conventional electric power plants convert only about one-third of their fuel source into electricity. The rest is waste heat. However, power generation can be boosted to 85 percent if the waste heat is reclaimed and used to provide thermal energy to buildings or industries.

If informed in an accurate and timely manner, consumers can also save energy. Federal government programs that require energy efficiency labeling on various products and appliances are an excellent example. Minimum efficiency standards have also been established for many major appliances.

The government can also lead by example, and many do. Agencies rely on the Federal Energy Management Program (FEMP) to reduce energy and water use, manage utility costs and promote renewable energy. In fact, by 1999 the federal government had reduced its energy use in buildings by some 28 percent compared to 1985 levels, primarily through the use of improved energy technologies. Energy efficiency improvements in vehicle and equipment fuel use have contributed to energy use reduction of about 35 percent in these areas during that same timeframe. State and local governments have the potential to achieve similar gains.

Residential and commercial buildings in the private sectors can realize similar gains, provided a number of obstacles can be overcome. The key is to:

- Increase the availability of highly efficient products,
- Improve automation in energy using goods and equipment, and
- Provide consumers with the information they need to pocket the benefits of wise energy use and proper investment in efficient appliances and devices.

Price signals and access to specific technologies are equally important in the industrial and agricultural sectors of the economy. More efficient motors and the increased use of cogeneration to create electricity are two examples of this approach. Increased research and development in industrial technologies produced greater efficiencies in motors. Government officials and the private sector should work together to ensure the widespread use of these new motors.

Transportation is another sector where energy efficiency gains can be significant. Currently, moving people and goods and delivering vital services accounts for about 28 percent of total U.S. energy consumption and more than two-thirds of petroleum consumption.

Fortunately, transportation technologies continue to improve steadily. However, the average fuel economy for most vehicles has remained relatively flat for ten years because of the increased popularity of larger vehicles such as SUVs and light trucks. Realizing significant efficiency gains in the transportation sector will not be easy. Most Americans place a high priority on their mobility and, as engines become more energy-efficient, drivers have increased the number of miles they drive each year. Conservation, increased use of mass transit and improvements in vehicle efficiency are the most important contributions that the transportation sector can make to national energy security.

POLICY RECOMMENDATIONS

- Expand and Strengthen the Energy Star Program
- Government should adequately fund its Low Income Heating Energy Assistance Program (LIHEAP) and weatherization programs.
- Expand and strengthen public education programs relating to energy efficiency.
- Expand the appliance standards program where technologically feasible and economically justified.
- Extend the Federal Energy Management Program to government facilities operated globally.
- Encourage increased energy efficiency through combined heat and power (CHP) projects.
- Provide tax incentives for highly efficient vehicles.

VI. ADVANCED ENERGY TECHNOLOGIES

In its 2001 report, *Toward a National Energy Strategy*, USEA members emphasized technology's important role in providing an efficient, safe, and environmentally sound energy system. In the aftermath of September 11, the need for advanced technologies to eliminate electric infrastructure vulnerability becomes even more compelling. However, energy systems have widely dispersed assets that can never be absolutely defended against a determined attack. Indeed, the intimate connections between energy systems and the other infrastructures of society lead to three different kinds of potential threats:

- **Attacks *upon* energy systems**. In this case, the energy infrastructure itself is the primary target—with ripple effects, in terms of power outages and fuel shortages, that extend into the customer base. The point of attack could be a single component, such as a critical substation or fuel storage facility. However, there could also be a simultaneous, multi-pronged attack intended to bring down the electricity grid throughout a major region of the U.S.
- **Attacks *by* an energy system**. In this case, the ultimate target is the population, using parts of the energy infrastructure as a weapon. Power plant cooling towers, for example, could be used to disperse chemical or biological agents, or a gas pipeline could be exploded in an area designed to maximize the resulting damage on people or buildings.
- **Attacks *through* an energy system**. In this case, the targets are diverse — ranging from the population and social infrastructure to business and military. Utility networks include multiple conduits for attack, including pipes, ducts for underground cables, tunnels and sewers. Underground conduits, for example, could be used to spread chemical or biological agents or to distribute combustible gas through buildings, utility vaults and sewers, and then ignited for a widespread urban calamity.

The Need for Advanced Technology

It is essential that a research and development program be created that will lead to the deployment of advanced technologies to address these concerns. Given the three scenarios described above, advanced technology can play a vital role in preventing terrorist attacks, mitigating the effects of a successful attack, and hastening recovery efforts afterward.

All energy systems are becoming more complex, as computer networks and advanced communications systems are used to automate processes that only recently were manually controlled. This circumstance raises a dilemma for improving energy infrastructure security: How can we make energy systems less vulnerable to attack without losing the economic advantages that have come with increased automation? One way to answer this question is to address five aspects of energy systems where advanced technologies are urgently needed to enhance security. Specific technological gaps are identified for each of these areas, together with a brief summary of the R&D needed to close these gaps.

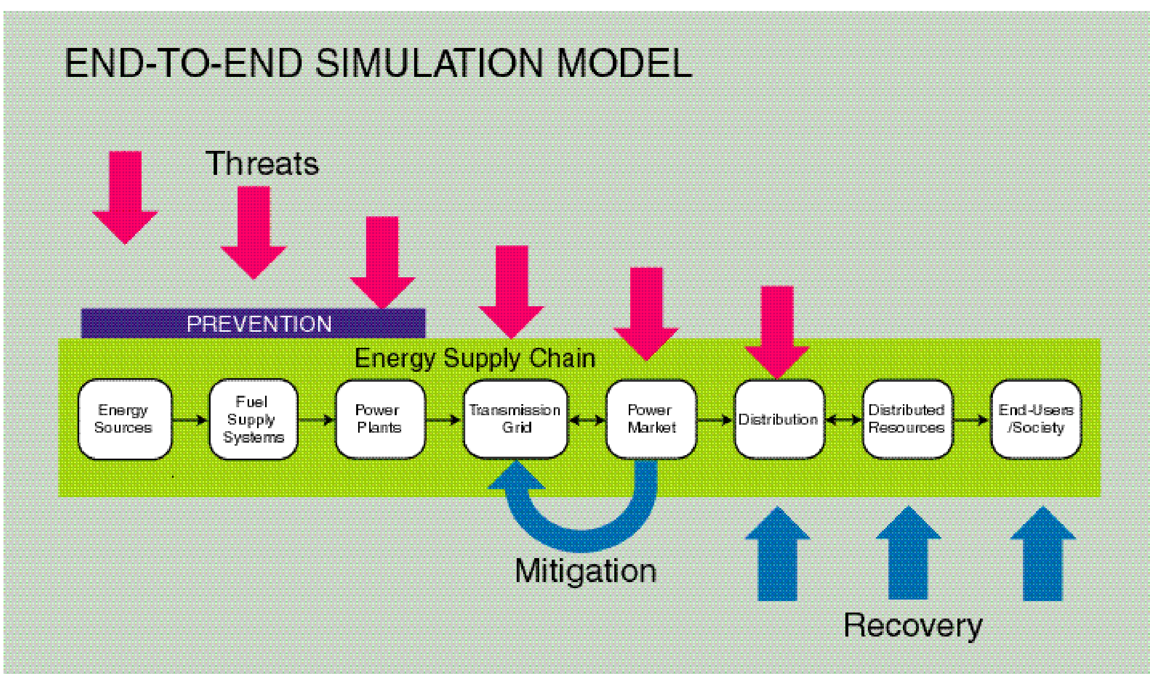
System-Wide Vulnerability Assessment

The first priority among efforts to improve overall energy system security is to assess the outstanding vulnerabilities to terrorism and identify the most effective counter-measures. Probabilistic Risk Assessment (PRA) is a well-established tool to determine system-wide risks from failure of critical components. PRAtechniques could be applied rapidly to conduct a preliminary assessment of North American energy system vulnerabilities to terrorism and where to focus counter-measures. Such an assessment would necessarily rely on existing simulation models for individual components along the energy supply chain.

The longer-term R&D effort would start with development of new, end-to-end simulation models that could integrate and extend existing models to cover each individual energy supply chain, such as electricity, petroleum, or natural gas. These new models could then be used to conduct a thorough Probabilistic Vulnerability Assessment (PVA), which would offer a more comprehensive and consistent evaluation of vulnerabilities and corresponding counter-measures. The end-to-end simulation models required would cover each chain from raw energy resources to end-users. These models could be used to show how coordinated threats on critical components anywhere along a supply chain can break the chain and propagate effects throughout a wide region, resulting in severe impacts on the system and on society.

Cyber and Communications Threats

As energy systems rely more heavily on computerized communications and control, ensuring system security has become increasingly dependent on protecting the integrity of these associated information systems. Part of the problem is that many existing control sys-



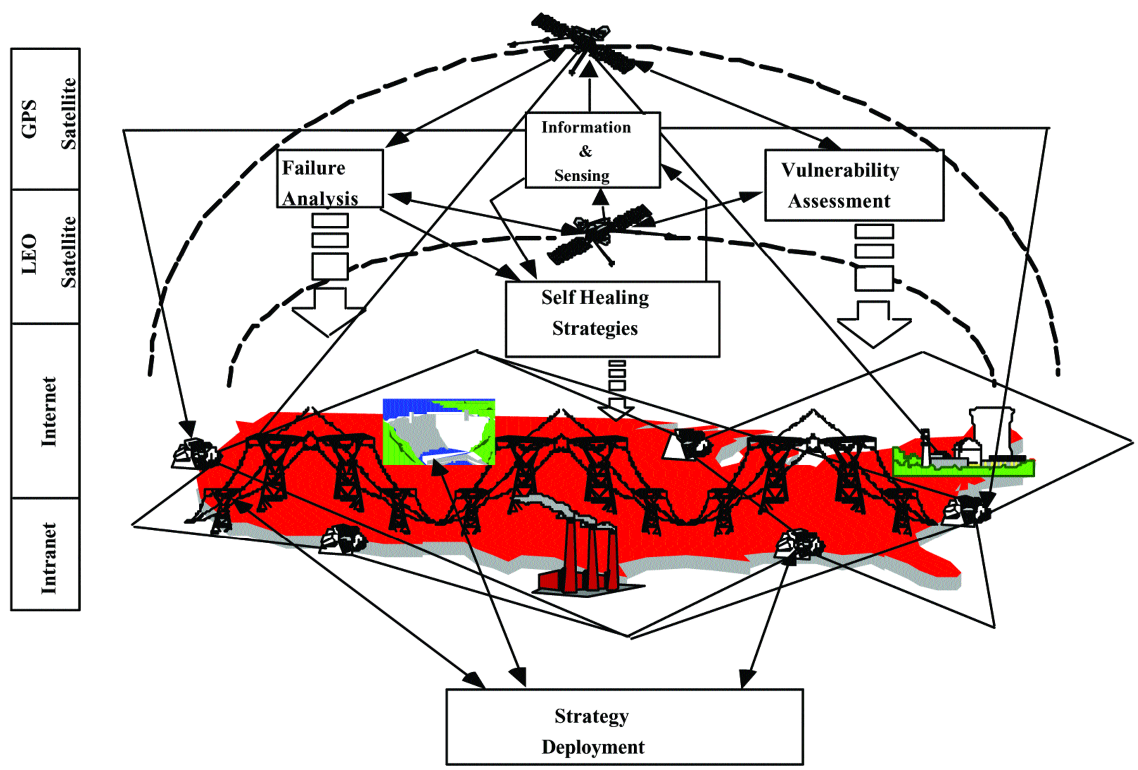
End-to-end simulation model for the energy supply chain: Knowledge of system-wide vulnerabilities that transcend the specific vulnerabilities of individual companies and components. Identification of systemic vulnerabilities should begin by adapting the probabilistic risk assessment (PRA) tools to the new terrorist-based environment.

tems were originally designed for use with proprietary, stand-alone communications networks. Later they were connected to the Internet because of its productivity advantages and lower costs – but without adding the technology needed to make them secure. As a result, the Internet may now represent the largest external threat to critical control systems. Two steps are needed to correct this problem:

- ▶ Eliminate Internet connections for critical monitoring and control systems. Until alternative communications networks can be provided, protocols should be developed to provide more protection and security while critical information systems still rely on the Internet.
- ▶ Develop wide-area, secure, private communications networks for energy systems. Because it may not be possible to provide sufficient security for using the Internet with critical energy system control applications, a new secure network needs to be developed. Such an effort would begin with a detailed evaluation of secure communications requirements, followed by development of a private, wide-area network with adequately protected primary and backup systems.

Electricity Grid Security

The high-voltage, electricity transmission grid represents one of the most geographically dispersed elements of the overall energy system, making it virtually impossible to "defend"



Cyber, communication networks and digital controls vulnerabilities: Response includes isolating critical controls and communication from the Internet, accelerating technical development of the Strategic Power Infrastructure Protection System (SPIPS), and developing self-healing substations for critical locations.

in a military sense. Transmission towers can be toppled by a single attacker armed with explosives or, in some cases, even a large wrench. Substations can be shorted out by dropping conductive carbon fiber or Mylar chaff from a small plane. At the same time, transmission networks are so highly interconnected that a local disturbance today can quickly spread throughout a regional power system. High-priority solutions include:

- **Adaptive intelligent islanding**. When major disruptions occur on a power system today, the transmission network automatically responds by breaking into self-contained "islands," according to fixed procedures that have been established well in advance. Such procedures have not generally been updated since the onset of deregulation and will not be adequate for dealing with a terrorist attack on multiple carefully chosen targets. Rather, a more flexible islanding method is urgently needed to minimize the overall impact of an attack, taking into account the location and severity of damage, load status, and available generation.
- **Self-healing grid**. An important task for longer-term R&D is to develop a "self-healing grid" – one capable of automatically sensing, isolating, and instantaneously responding to power system disturbances, while continually optimizing its own performance. Such a self-healing paradigm would not only make power delivery systems less vulnerable to terrorist attack, but would also improve the efficiency and reliability of daily operations. The key technologies needed are electronic monitoring of control capabilities that can be integrated over the growing scale and interconnected complexity of the delivery system.

High-priority technologies to counteract and mitigate cascading outages include adaptive intelligent islanding and self-healing grid.

Local Disaster Preparedness

Attacks on local energy systems are generally considered less likely to cause widespread effects than those involving large, centralized facilities or transmission systems, but nearby effects could be devastating. Energy systems are also likely to sustain major collateral damage as the result of attacks on other infrastructures, particularly in urban centers. The recent assault on the World Trade Center, for example, knocked out power to five distribution networks in New York City and destroyed two electricity distribution substations. Conversely, an attack on key portions of a distribution system could be used to cause power outages at critical loads, such as hospitals, emergency response centers, and financial hubs. Technology developments that could help prevent or reduce such damage from terrorist attacks include:

- **Local vulnerability assessment**. Such an effort represents a bottom-up approach to vulnerability assessment and thus complements the top-down approach of PVA, described above. R&D will be needed to develop a computerized self-assessment tool that local utilities can use to identify vulnerabilities of their own systems and to estimate the potential impact of terrorist attacks.
- **Underground gas sensors**. A system of gas detectors and warning alarms should be installed at critical points in the underground infrastructure of electric and other utilities. This detector-and-alarm system should be protected from disablement by terrorists.
- **Software to support local resource management and mutual aid**. Energy utilities have a major role to play in the mitigation and recovery process from disasters, whether natural or man-made. New software should be rapidly developed that could help identify available resources after a terrorist attack and coordinate recovery efforts among mutual-aid partners and other stakeholders.

It is imperative that a public/private partnership be created to launch a research and development program for advanced energy security technologies. Such programs would support the development and deployment of technologies needed to protect North American energy systems, and in many cases, improve their efficiency, environmental quality and reliability as well. With collaborative leadership, the advanced technologies to resolve our energy security issues can be developed and deployed. Working together, government officials and the energy industry can ensure that the nation's energy system will continue to serve as the foundation of our economic prosperity and domestic security.

Major Energy Facilities

Major energy facilities—such as petroleum refineries and power plants—must be considered prime targets for attacks on populations through the energy infrastructure. The cooling towers present in most power plants, for example, could conceivably be used to disperse chemical or biological agents. Although such dispersion would probably cover a limited geographical area, the agent could infect a small number of victims, either human or animal, who could then serve as vectors to the larger population. Furthermore, introduction of the agent might not be detected until dispersion had been accomplished. A three-step approach is recommended to counter this threat:

- **Develop and install sensors to detect dangerous agents**. Work is underway in government and private laboratories to identify and characterize both chemical and biological agents that could be used in a terrorist attack. This knowledge should be applied to determine which agents could exist at the temperature, moisture, and chemical conditions of a cooling tower, and to develop sensors for detecting such agents.

- **Identify methods to destroy dangerous agents**. Such methods, for example, might involve addition of treatment chemicals to destroy or de-nature the agent within the cooling tower or other energy facility, as well as in the surrounding environment. Procedures also need to be developed specifying exactly what steps should be taken on discovery of the presence of an agent in an energy facility.
- **Create contingency plans**. Many approaches and tools for contingency planning have been developed and used by the utility industry for a variety of environmental threats, including oil spills, fires etc. The energy industry should coordinate with government agencies to consider how to use and modify existing contingency plans for chemical and biological incidents involving terrorism.

POLICY RECOMMENDATIONS

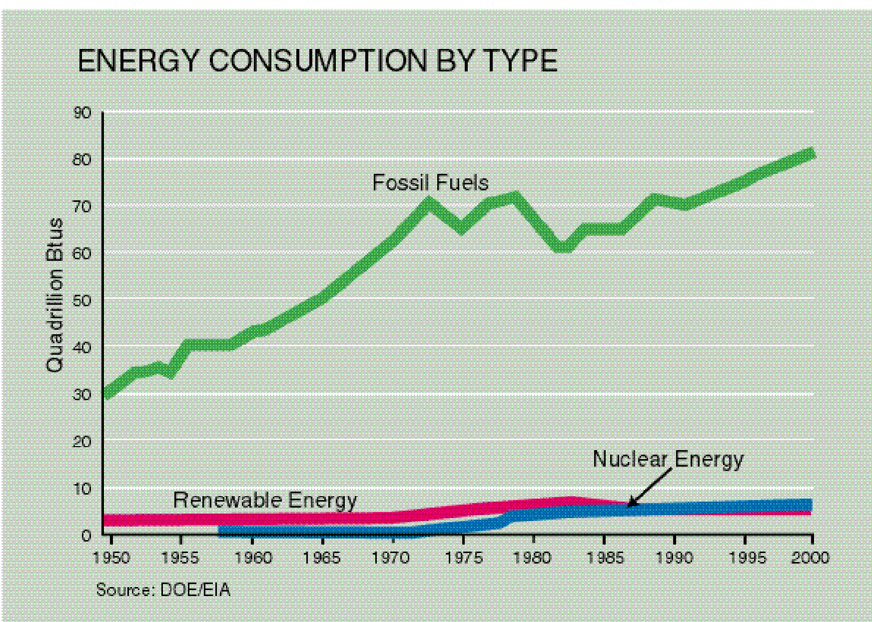
A research and development program should be established to support the deployment of these advanced technologies needed to eliminate infrastructure vulnerability. Advanced technologies can play a vital role in preventing, mitigating against, and hastening the recovery from attacks upon our energy system. Through the creation of public/private partnership, these technologies can be enabled to ensure the security of our nation's energy infrastructure. These technologies will also serve to reduce other growing vulnerabilities to the nation's energy infrastructure – particularly its reliability and capacity.

VI. SOME CONCLUDING THOUGHTS

Any discussion involving national energy security is certain to raise a number of debatable issues. Increases in energy production heighten the concern of adverse environmental impacts from energy production, transportation, utilization and waste disposal activities. Some suggest that more stringent regulation of energy activities, coupled with improvements in efficiency and additional conservation can, in themselves, accommodate the U.S. economy's growing energy appetite.

This report, *National Energy Security Post 9/11*, makes clear that the threat to U.S. energy security is real. It is intended as a call to action by our members who represent a broad spectrum of energy-related organizations in the public and private sectors. The threats to U.S. energy supplies, energy infrastructure and public confidence are real and must be addressed. This report proposes actions and policies necessary to properly prepare for the nation's energy needs, and, in the event disruptions do occur, it makes proposals that would mitigate interruptions in energy supplies. We need not and should not take a passive approach to this challenge.

However, the adoption of these proposals to improve national energy security should not imply that the energy industries do not share concerns regarding environmental impact. Since 1950, increases in energy use have been accompanied by the introduction of new emission control technologies and significant improvements in overall energy efficiency. The magnitude of these efforts has been extraordinary. Overall energy efficiencies have reduced energy use per dollar of gross national product by almost one-half. Emissions from fossil energy combustion have been significantly reduced despite the huge increases in fossil energy consumption over the period. Despite a tripling in fossil energy use since 1950, technologies now in place have reduced NO_x and SO_2 emission by 40 percent and 50 percent respectively from their previous high levels. In addition, programs in place are reducing mercury emissions by 40 percent.



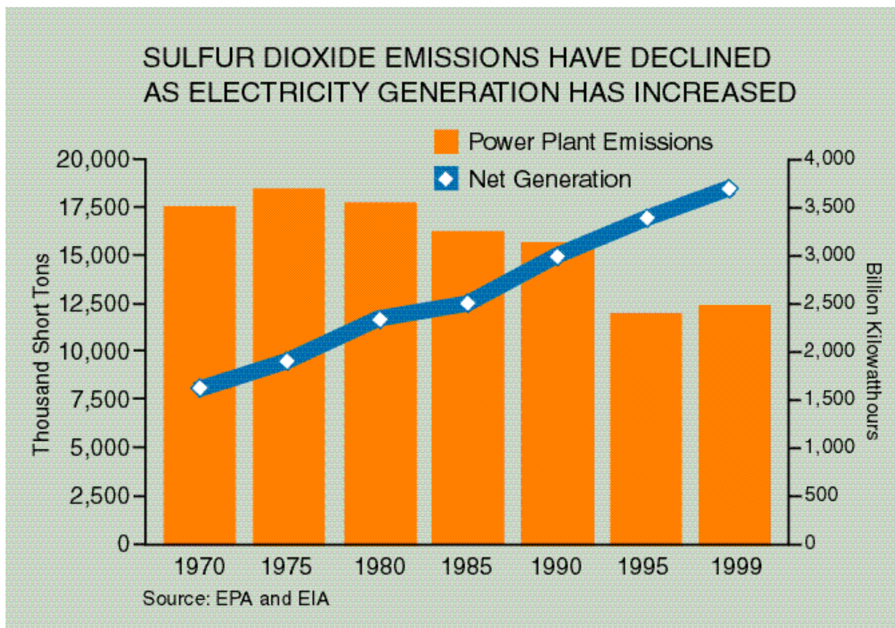
The lesson is simple. Energy security requires carefully orchestrated planning and implementation. It can be accomplished without sacrificing environmental objectives. The answer is not regulation and constraint, but rather the continued research, development and introduction of the technologies necessary to accommodate both economic demands for increased energy supplies and improved environmental performance.

USEAmembers believe that a difference can be made in our national energy security by:

- ▶ Encouraging conservation and energy efficiency through better education and information on energy issues, energy use and energy prices. More effective consumer choices, investment decisions by companies and policy decisions at all levels of government will all be enhanced through energy information transparency.
- ▶ Implementing policies that facilitate access to and development of domestic energy supplies in an environmentally responsible manner. Policies that encourage cost effective development of diverse energy sources of all types of energy on a global basis can make a significant contribution to robust and diverse energy markets.
- ▶ Developing and continually monitoring contingency plans and emergency preparedness procedures regarding all facets of energy activities.

USEA members believe that the implementation of the policies recommended in this report can change the outcomes in the business as usual energy trends projected by the DOE/EIA. Specifically:

- ▶ U.S. oil import dependency from unstable sources of supply can be slashed dramatically in the next decade.
- ▶ Critical energy infrastructure protection can be enhanced significantly through advanced technology.



- ▶ Energy security, economic and environmental concerns can be balanced effectively.

Finally, a word about the future of energy on Planet Earth. With a current population of six billion people, and with forecasts that population will increase to nine billion by 2050, it is obvious that the demands for energy in the immediate future will surpass anything yet seen. Globally, the most prevalent concern will be the amount of poverty, and the preponderance of that problem will exist in developing countries of high population density. Few, if any, of these nations possess any semblance of an energy structure, or for that matter, a viable economy. This situation must be addressed. Some form of "Energy Marshal Plan for Developing Countries" must be put into place if we are to successfully "bridge the gap" between the haves and the have-nots of the 21st Century.

This issue will receive the attention of USEA members in a following report.

ABOUT USEA AND THE NATIONAL ENERGY SECURITY REPORT

The United States Energy Association (USEA) is the U.S. Member Committee of the World Energy Council (WEC). USEA is an association of public and private energy-related organizations, corporations and government agencies. USEA represents the broad interests of the U.S. energy sector by increasing the understanding of energy issues, both domestically and internationally.

In conjunction with the U.S. Agency for International Development and the U.S. Department of Energy, USEA sponsors our nation's Energy Partnership Program. USEA sponsors policy reports and conferences dealing with global and domestic energy issues as well as trade and educational exchange visits with other countries.

The USEABoard of Directors agreed that a follow up report to the USEAreport "Toward a National Energy Strategy" (February 2001) should focus on National Energy Security particularly in light of the tragedy of September 11, 2001. The board approved the National Energy Security project under the leadership of Richard Lawson, Chairman of its National Energy Policy Committee. Guy Caruso directed the project. Tom Kirlin organized and edited the text. Hal Baskin provided cover and booklet design. A working group representing all sectors of the energy industry has prepared the report.

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